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A Memorandum Report on the Application of CALSIM II Model At 2020 Level-of-Development

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I Purpose of the Report

The purpose of this memorandum report is twofold:

1) To highlight the salient features of the CALSIM II system-wide simulation model for SWP/CVP projects.

2) To demonstrate the application of the model at the 2020 level-of-development simulating the Interior's October 5, 1999 (b)(2) Decision[1] and the Environmental Water Account (EWA) under CALFED ROD/Framework regulatory environment.

The modeling study presented in this report is merely an example. The results of the study are intended to show the capability of the model to simulate the complex project operations rules and criteria. It is not a standard baseline study and neither DWR nor USBR recommends the results of this study be used beyond the limited purpose of this report.

The model is usually intended to be used in a comparative mode. The results from a "with project" simulation should be compared to the results of a baseline simulation to obtain the incremental effect of a project on the system. The results from a single simulation may not necessarily represent the exact operations for a specific month or year, but should reflect long-term trends.

Formulation of the CVPIA(b)(2) and EWA criteria and the resulting operations of the two projects will likely be refined with input and suggestions from the interested parties to carry out a more specific study to meet a particular need in the future.

II CALSIM Joint SWP/CVP Planning Model

II.1. CALSIM Planning Model

CALSIM is a general-purpose planning simulation model developed jointly by DWR and the US Bureau of Reclamation for simulating the operation of California's water resources system, and in particular the coordinated operation of the California State Water Project (SWP) and the Federal Central Valley Project (CVP). The model replaces DWR's prior planning simulation model DWRSIM, as well as USBR's PROSIM and SANJASM models that simulate operation of the CVP. The agencies now share a common approach to modeling project operations for planning purposes. The version of CALSIM used for the study presented in this report is CALSIM II.

CALSIM represents a fundamental change in the approach to constructing simulation models of California's water resources system. Model users now specify system objectives and constraints as input to the model, rather than embedding goals and logic in thousands of lines of procedural code as is common in traditional

1. Department of the Interior Decision on Implementation of Section 3406 (b)(2) of the Central Valley Project Improvement Act.

simulation models. While CALSIM is not a prescriptive optimization model, it utilizes optimization techniques to route water through a network of nodes and links. A Mixed Integer linear Programming (MIP) solver determines the optimal set of decisions for each time period given a set of user-defined priorities or weights and a set of system constraints. It should be noted that while the current application of CALSIM is to California, the structure of the CALSIM engine is highly generic. As such the model can be applied to analyze any water resources system. The model includes a graphical user interface for input of data, making model runs and viewing results.

Currently CALSIM simulates project operations for a given level-of-development over a 73-year time period using a monthly time step. The level of development (land use) is held constant over the period of simulation. The inflow hydrology is based on the historic period 1922 to1994 but modified to reflect the influence of changes in land use and upstream diversion and flow regulation in areas upstream of the model. Results, therefore, represent a range of possible water supply conditions at a particular snapshot in time. Results should be interpreted in terms of supply reliability rather than representing a particular sequence of annual operations.

II.2. Model Details

The key component of CALSIM is the specification of physical and operational constraints using a new modeling language, Water Resources Engineering Simulation Language (WRESL) and associated text tables. The model user describes the constraints of the physical system (dams, reservoirs, channels, pumping plants, etc.) and operational rules (flood-control diagrams, minimum instream flows, delivery requirements, etc.) entirely in WRESL statements. The statements are then assembled into WRESL files using a tree-structure for organization of related constraints. CALSIM utilizes the HEC-DSS data storage system developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center in Davis, California to store all time series data. Relational data such as index-dependent flow standards and monthly flood control diagrams are stored in simple, text-based, relational tables. The text tables also contain the conductivity matrix for the network and the user-defined weights that are incorporated into the objective function. At model run-time the WRESL statements and data from the DSS database and the text tables are converted into a matrix or array that is passed to the MIP solver.

II.3. Model Limitations

CALSIM II operates on a monthly time step. Decision variables (e.g. reservoir releases, Delta inflow) are assumed constant over this period. Various assumptions must be made to model standards or flow requirements that are not constant over a calendar month. During the rain-flood season storm runoff will result in peak flows that are considerably higher than the monthly average. This may lead to an over-estimate of the ability to export flows from the Delta.

CALSIM II simulates the entire CVP/SWP system stretching in geographical extent from Lake Shasta to Castaic Lake and Lake Perris at the southern end of the

Californian Aqueduct. The model focus is system-wide operations. Large areas are aggregated to simplify the model representation. Though this aggregation generally does not decrease model reliability, it limits the model's use for studying local project operations.

III New Developments, CALSIM II

III.1. Overview

CALSIM II is intended to replace the Department of Water Resources (DWR) and the United States Bureau of Reclamation (USBR) currently used models: CALSIM I (DWRSIM), PROSIM and SANJASM. The study described in this report is its first application. Changes from CALSIM I are to the application of the generic CALSIM model to the California system and not to the underlying software; changes have been made to the WRESL files and associated text tables. Much of the early construction of CALSIM I was focused on reproducing results from DWR's former model, DWRSIM. Improvements in CALSIM II include:

Improved schematic (node-link network);

Explicit and dynamic modeling of groundwater;

Revised modeling of demands; and

Improved salinity-flow relationship for the Delta.

III.2. Improved Schematic

Substantial changes have been made to the representation of flows in the Sacramento Valley. The aim is to switch to a more physically based network in which links correspond to actual flow paths. The representation of the Sacramento Valley is based on seven hydrologic units or Detailed Study Areas (DSAs). Flows across DSA boundaries may reasonably correspond to actual flows. However stream flows within each DSA may not have a physical counterpart and represent some aggregation of flows. Improvements to the new schematic include:

Greater spatial detail with explicit representation of canal imports and exports between DSAs;

Representation of wildlife refuges;

Explicit representation of flood-bypasses; and

Inclusion of the East-Side streams (Cosumnes, Mokelumne, Calaveras).

III.3. Modeling Groundwater

CALSIM II explicitly models groundwater within the Sacramento Valley using a multiple-cell approach. In plan view, if a major stream (Sacramento River, Feather River, or American River) passes through the DSA, the entire DSA is divided into two aquifers: a "strip" aquifer, and a "main" aquifer. Otherwise, the entire DSA is assumed to be one aquifer. Groundwater within each aquifer is treated as a single homogeneous cell of infinite transmissivity. For the Sacramento Basin, there are a total of 14 cells. Groundwater flows represented dynamically are

Groundwater pumping;

Groundwater recharge from applied water;

Stream-groundwater interaction; and

Inter-aquifer lateral groundwater flow.

Pre-processed flows are:

Groundwater recharge from precipitation; and

Boundary inflow from the surrounding foothills into the Valley floor.

Flows between aquifers and between stream and aquifer are based on Darcy's Law. However flow equations use head values at the beginning of the time step. This removes the influence of groundwater on current surface water operational decisions; for example minimization of stream seepage is not considered.

The explicit representation of groundwater in CALSIM II overcomes the confusing hydrologic accounting that was the basis for both CALSIM I (DWRSIM) and PROSIM, whereby gains represent a mix of local surface water and historic groundwater extraction. The explicit modeling of groundwater also lays the foundation for future integration of CALSIM II with the Central Valley Groundwater Surface Water Model (CVGSM), a quasi three-dimensional finite-element groundwater model for the Central Valley.

The historical run for CVGSM (version 5.0) was used to calibrate the multiple-cell model within CALSIM. However the multi-cell approach is unable to fully capture the response of the aquifer to external stresses. At this stage interpretation of impacts of surface water operations on groundwater should be treated with caution. All interpretation should be comparative between model runs. Absolute values of aquifer head and storage may be misleading.

III.4. Revised Demands

Within the Sacramento Valley demands for each DSA must be disaggregated into project and non-project components. Project demands are subject to reduced water allocations based on contracts with the CVP and SWP, while non-project demands are satisfied from sources other than the CVP and SWP. The project/non-project split in CALSIM II is based on federal and state (FRSA) district boundaries superimposed on land use county surveys completed by DWR during the 1990s. New rules have been developed for allocating surface and groundwater supplies. Unlike CALSIM I all allocations and deficiencies to CVP and SWP contractors are modeled dynamically. Demands are initially met by a pre-determined minimum groundwater pumping. Subsequently demand is met from available surface water supplies. If the available surface water is insufficient to meet full demand, additional groundwater pumping occurs. There is currently no limit on maximum groundwater pumping. Over-drafting of groundwater basins is evident in some aquifers.

III.5. Salinity-Flow Relationships for the Delta

Determination of flow-salinity relationships in the Sacramento-San Joaquin Delta is critical to both project and ecosystem management. Upstream reservoir operations, as modeled in CALSIM, are often dictated by the need to meet Delta salinity standards. However, the salinity in the Delta cannot be modeled accurately by the simple mass balance routing used in CALSIM. To simulate salinity-flow relationship and carriage water requirements in the Delta, CALSIM II is integrated with an Artificial Neural Network (ANN) model. The ANN replaces the Minimum Delta Outflow (MDO) curves and G-Model that were used in earlier versions of CALSIM and DWRSIM. This represents a major improvement in determining salinity standard water costs and impacts to the projects. Flow-salinity relationships are now dynamically represented with salinity being a function of both the flow pattern through the Delta and antecedent flow conditions. The ability of the ANN to be retrained when and if the configuration of the Delta changes represents a significant enhancement over prior models. It is noted that the ability to use the G-Model has been retained in CALSIM II.

DWR's Delta Simulation Model (DSM2) is a one-dimensional hydrodynamic model capable of simulating flow, stage, and water quality throughout the Delta. The ANN developed by DWR attempts to statistically correlate the salinity results from a particular DSM2 model run to the various peripheral flows and the operation of the Delta Cross Channel. The ANN is "trained" on DSM2 results that may represent historical or future conditions. For example, a reconfiguration of the Delta channels to improve conveyance may significantly affect the hydrodynamics of the system.

The current ANN module predicts salinity at various locations in the Delta as a function of the Sacramento River inflow, San Joaquin River inflow, Delta Cross Channel gate position, and total exports and diversions. A total of 148 days of values of each of these parameters are included in the correlation, representing an estimate of the length of "memory" in the Delta.

CALSIM utilizes a linear programming solver for determining routing of water throughout the modeled system. This necessitates approximation of the ANN flow-salinity relationship and the salinity standards by a linear flow constraint. The major independent (and unknown) flow parameters that have a significant influence on salinity are the Sacramento River flow (Q_{SAC}) and the combined project exports at the Tracy and Banks Pumping Plants (Q_{EXP}). Salinity standards can therefore be imposed in CALSIM using flow constraints of the form:

$$Q_{EXP} = m\, Q_{SAC} + b$$

The slope (m) and intercept (b) are calculated from the ANN using the prior month's Sacramento River inflow, San Joaquin River flow, total exports, and Cross Channel gate operation and on the current month computations of Cross Channel gate, Yolo Bypass, channel depletions, East Side Streams, San Joaquin River, and North Bay and Contra Costa diversions.

Currently the ANN is used to predict salinity at three locations: Old River at Rock Slough, San Joaquin River at Jersey Point, and Sacramento River at Emmaton. A "Full Circle" analysis (DSM2-ANN-CALSIM-DSM2) indicates that the ANN over-estimates salinity for Rock Slough, compared to DSM2. Consequently salinity estimates for Rock Slough are based on a correlation to those predicted by ANN at Jersey Point.

IV Example Model Study

IV.1. Modeling Assumptions

An example model study has been completed at the 2020 level-of-development simulating assumed operation criteria under CVIA (b)(2) and the concept of EWA. The section discusses the key modeling assumptions, modeling procedure and CVPIA (b)(2) and EWA proposed criteria.Modeling Assumptions

Appendix A presents the general modeling assumptions used in the example study. Appendix A compares the regulatory standards, instream flow requirements, and other operational constraints between Decision D1485, Decision D1641, CVPIA (b)(2) proposed fish actions and EWA imposed additional fish protection measures.

- SWP south-of-Delta demand was assumed to vary from 3.3 maf to 4.2 maf/yr.
- SWP north-of-Delta demand was assumed to be 830 taf/yr.
- CVP south-of-Delta demand was assumed to be 3.5 maf/yr.
- CVP north-of-Delta Sacramento River demand was assumed to be 2.8 maf/yr.
- CVP American River demand was assumed to be 720 taf/yr. based on the Water Forum 2030 demand.
- Stanislaus River demand was assumed to be 680 taf/yr.
- Contra Costa Water District demand was assumed to vary from 95 to 202 taf/yr.

Banks Pumping Plant limit is 6,680 cfs and can be increased to 8,500 cfs during 15 December through 15 March when the San Joaquin River flow at Vernalis is above 1,000 cfs.

From July through September, EWA is given 500 cfs additional Banks Pumping Plant capacity from July through September. Total Banks Pumping Plant capacity is increased to 7,180 cfs from July through September. Banks Pumping Plant capacity for SWP and CVP is limited to 6,680 cfs.

EWA and CVP share equally joint-point-of-diversion capability whenever there is excess capacity available at Banks Pumping Plant.

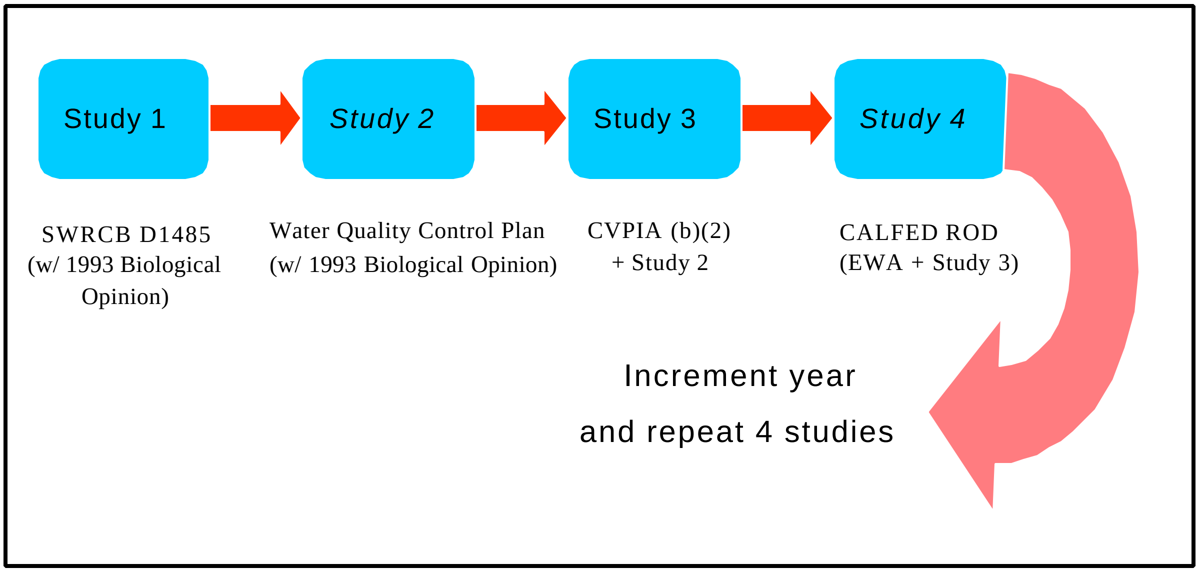
IV.2. Application of CALSIM II Model to Simulate CVPIA (b)(2) and Environmental Water Account Operations

IV.2.1. General Modeling Procedure

Modeling of the CVPIA (b)(2) and Environmental Water Account (EWA), under the CALFED Framework and Record of Decision (ROD), represents a significant departure from the traditional long-term planning analyses and more closely represents position analyses or gaming simulations. Layering criteria and accounting based on water supply with particular actions, requires an analysis of several sequential annual studies. CVPIA (b)(2) accounting procedures require the system be known under D1485 and WQCP operations. Similarly, the south of Delta deliveries and storage to be maintained by the EWA are determined in part from the (b)(2) analysis (CVP base is directly the result of the (b)(2) study, while the EWA receives half of the SWP (b)(2) gain). Due to the layering of constraints and operations required under the CALFED Framework/ROD, a modeling analysis has been developed to dynamically integrate four simulations for each year of the hydrologic sequence while resetting the state of the system each year to that of the final simulation. The general modeling procedure follows these steps and is shown graphically in Figure 1:

- Run the D1485 simulation for October through September of the current year
- Run the WQCP simulation for October through September of the current year
- Run the B2 simulation for October through September of the current year, dynamically accounting for WQCP costs and (b)(2) account balance, and implementing fish protection actions according to a preference matrix
- Run the EWA simulation for October through September of the current year, taking all (b)(2) actions from the (b)(2) run, dynamically accounting for debt and collateral, and implementing fish protection actions according to a preference matrix
- Reset the state of the system for all simulations (D1485, WQCP, (b)(2), and EWA) to that resulting from the completed EWA run. This will serve as the initial condition for the next year's simulations. Storage, X2, and any other variable requiring an initial state will be taken from the EWA run
- Repeat steps 1 to 5 for all years of the period of record

Figure 1. Modeling Approach for CVPIA (b)(2) and EWA Operations



IV.2.2. CVPIA (b)(2) Operations and Accounting

CVPIA (b)(2) allocates 800 taf (600 taf in Shasta critical years) of CVP project water to be dedicated to targeted fish actions. Of this amount, up to 450 taf is to be used to implement the WQCP Delta requirements. Potential CVPIA (b)(2) actions are given in Table 3.

Table 3. Matrix of Potential CVPIA (b)(2) Actions

Action	Description	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	AFRP Releases (Nov. 20th, 1997)												
2	Export Reductions (150 taf)												
3	VAMP Export Restrictions												
4	VAMP Export Restrictions Extension – Post												
5	Export Ramping – EI												
6	VAMP Export Restrictions Extension – Pre												
7	Export Reduction (35 taf)												
8	Upstream Releases												

CVP

Note: CVPIA(b)(2) actions are dynamically simulated and are limited to the (b)(2) account (800/600 taf). These actions are imposed on the CVP system.

CALSIM implements a dynamic modeling procedure that tracks (b)(2) account balance and determines operational decisions based on the remaining amount of (b)(2). At the beginning of each month of simulation, the current month WQCP cost is deducted from the current account balance. According to the resulting balance (after WQCP cost deduction), (b)(2) actions are taken according to an input-action matrix. Several actions may have reserve amounts that serve to limit (b)(2) expenditures for lower priority actions early in the year so higher priority actions can be met. At the end of each month, the cost of the (b)(2) action (measured against the WQCP) is also deducted from the account. The next month will then be simulated in the same manner. An example of the simulation/accounting procedure for one month:

- Beginning (b)(2) account balance
- Determine D1485 and WQCP results for the current month
- Determine WQCP cost for current month
- Update (b)(2) account balance = (1) – (3)
- Take actions in the current month according to the state of the system and account balance (using the action matrix).
- Determine actual cost of actions (compared to WQCP) taken in the current month
- Update (b)(2) account balance = (4) – (6)
- Updated balance in (7) becomes the beginning (b)(2) account balance for the next month

The expenditure of (b)(2) water is measured according to the metrics developed by the Department of the Interior. Total (b)(2) cost is the sum of the storage, release, and export metrics. A brief definition of the metrics follows:

Storage Metric *(October through January):*

Change in 31 January CVP storage at Trinity Lake, Shasta Lake, Folsom Lake, and New Melones reservoir.

Release Metric *(February through September):*

Change in CVP releases from Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and Goodwin Dam.

Export Metric (*October through September*):

Change in CVP exports at Tracy Pumping Plant and SWP wheeling for the CVP at Banks Pumping Plant.

Reset Provision *(October through January):*

The “reset” term applies to refilling of CVP reservoirs by 31 January. Reset is the difference between the maximum storage decrease and the final decrease by 31 January. The modeling applies this reset water towards upstream release actions.

Offset Computation *(February through September):*

The term “offset” refers to the quantity of water needed to keep the change in cumulative releases from going negative in the February through September period, i.e. a net credit under the release metric is not allowed in the (b)(2) accounting. Since the (b)(2) account is updated monthly in CALSIM II, the offset is computed monthly, and the (b)(2) account is updated with offset adjustments monthly.

SWP/EWA Gain (October through September):

SWP/EWA gain refers to the increased SWP export from the Delta that occurs as a result of upstream CVP (b)(2) releases. This gain is shared evenly between the SWP and EWA.

IV.2.3. EWA Modeling

Modeling of the Environmental Water Account follows a procedure similar to (b)(2). The EWA takes fish protective actions, both upstream and in the Delta, to the extent possible with the existing collateral. Potential EWA actions are given in Table 4.

Table 4. Matrix of Potential EWA Actions

Action	Description	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	AFRP Releases (Nov. 20th, 1997)												
2	Export Reductions – 4000 cfs for one week each month (2 weeks in Wet years)												
3	VAMP Export Restrictions												
4	VAMP Export Restrictions Extension – Pre												
5	VAMP Export Restrictions Extension – Post												
6	Export Ramping – EI												

CVP CVP/SWP

Note: EWA actions are dynamically simulated and are limited to the EWA collateral.

South-of-Delta deliveries and storage are not to be adversely affected by the EWA as per the CALFED Framework and Record of Decision. The project deliveries and storage to be maintained are:

CVP Del + Sto = (b)(2) Del + (b)(2) Sto + 50% JPOD
SWP Del + Sto = WQCP Del + WQCP Sto + 50% (b)(2) gain

EWA assets set forth in the CALFED Framework and Record of Decision that the EWA uses to accumulate collateral south of the Delta so that it can take EWA actions and use it to pay debts to the projects:

50% of SWP gain of upstream (b)(2) releases

50% of joint-point-of-diversion availability

500 cfs additional Banks Pumping Plant capacity from July through September

North of Delta purchase: 35 taf/year

South of Delta purchase: 50-200 taf/year (wet=200, above and below normal=150, dry=100, critical=50, using 40-30-30 index)

South-of-Delta groundwater storage (200 taf initial storage with 20 taf/month recharge/pump rate)

The EWA uses these assets to accumulate collateral south of the Delta in order to take fish protective actions that will affect project operations. The terms ***debt*** and ***collateral*** are thus extremely important to the EWA. Debt is a measure of the difference between the current project deliveries and storage and that of the EWA base. Collateral, on the other hand, is a measure of the ability of the EWA to compensate the projects for reductions in delivery and storage in the current water year. Delivery debt is directly repaid to the projects in the month it occurs. Storage debt is repaid to the projects by the end of September.

A maximum of 100 taf/yr (5 months x 20 taf/month) of groundwater storage is considered in the collateral computation for the EWA. EWA groundwater storage is pumped for project delivery during April through September only when EWA San Luis reservoir storage falls below that needed to repay the project-storage debt. Recharge to EWA groundwater occurs when EWA San Luis reservoir storage is sufficient to repay project storage debt and EWA water is capable of being moved through Banks Pumping Plant.

When the EWA takes an action to reduce exports, the amount of storage backed up in Lake Oroville, Shasta Lake, or Folsom Lake as a result of EWA imposed export reduction is credited to the EWA account in those reservoirs. The EWA can transfer its water from those reservoirs into its San Luis reservoir account with joint-point-of-diversion at Banks Pumping Plant.

IV.3. CVPIA (b)(2)/EWA Modeling Assumptions

SWP share of 50% of (b)(2) gain was assumed stored in SWP San Luis reservoir when (b)(2) gain is available.

CVP water transferred through joint-point-of-diversion was stored in CVP San Luis reservoir.

The required X2 days at Roe Island in the (b)(2) and EWA studies were fixed to the WQCP study so that no additional Roe Island standards were triggered in the (b)(2) and EWA in order to keep the X2 standards from influencing the (b)(2) accounting.

Delivery allocations for the SWP and CVP were fixed to the delivery allocations from the WQCP study and (b)(2) study, respectively.

Reserve amounts were provided for lower priority (b)(2) actions early in the year so that the higher priority (b)(2) actions, such as VAMP, that occur later in the year were taken more frequently. Reserve amounts were provided for (b)(2) Action 2 (December and January export reduction), (b)(2) Action 6 (pre-VAMP), and (b)(2) Action 7 (February and March export reduction). In the model, the remaining (b)(2) account was checked against the reserve amounts to determine whether an action was taken. If the remaining (b)(2) account was more than the reserve amount and the estimated remaining WQCP cost, then the action was taken. Otherwise, the action was not taken. The reserve amounts were the estimated costs of the actions.

IV.4. CVPIA (b)(2)/EWA Modeling Limitations

The following is a list of (b)(2) and EWA operating rules not currently modeled in CALSIM II yet:

Joint-point-of-diversion (JPOD) should be activated when SWP San Luis reservoir is full (physical + EWA storage debt to SWP San Luis reservoir) and interruptible demands have been met under surplus conditions. Currently in CALSIM, JPOD is not activated until SWP San Luis reservoir is physically full and interruptible demands have been met. This delays JPOD somewhat but by increasing SWP San Luis reservoir storage, EWA debt is reduced.

In CALSIM, all EWA debt was assumed to be repaid to the projects by the end of the water year. No carryover of EWA debt was included. Any debt that the EWA could not repay because the EWA did not have sufficient collateral in any year was assumed to be paid from unspecified sources of water. The amount of debt that the EWA could not repay is identified as unpaid debt. For modeling convenience, it was assumed that the EWA could accumulate additional collateral from unspecified sources, perhaps by increasing south of Delta purchase, to pay the debts.

EWA E/I relaxation and source-shifting agreements are not modeled.

In the CVPIA (b)(2) study, export at Banks Pumping Plant should not increase above the baseline pumping in the WQCP study when a (b)(2) export action is taken by CVP. In the current formulation of CALSIM, export at Banks Pumping Plant is allowed to increase above the WQCP baseline when a (b)(2) export action is taken.

By allowing export at Banks Pumping Plant to increase above the WQCP baseline when a (b)(2) action is taken could lead to overestimating SWP (b)(2) gain and joint-point-of-diversion benefits for the CVP and EWA. Remedies to this limitation is being investigated.

V Example Study Key Modeling Results

This section presents key results regarding project operations as well as CVPIA (b)(2) and EWA operations as simulated by the model.

V.1. Water Supply

Table V.1.1
Water Supply
(taf/year)

Delivery	(May 1928 - Oct. 1934) Dry Period Average	(1922-1994) 73-Year Period Average
Total SWP south-of-Delta Firm Delivery	1717	2922
Total SWP Interruptible Delivery	66	195
Total CVP north-of-Delta Delivery	2059	2249
Total CVP south-of-Delta Delivery	1560	2147
Total CVP south-of-Delta Agricultural Delivery	241	667
Total Delivery	5402	7513

Table V.1.1 shows the average annual deliveries for the SWP and CVP for the historical dry period of 1928 through 1934 and 73-year long-term. The average annual SWP south-of-Delta firm delivery in the dry period of 1928 through 1934 is 1,717 taf and 2,922 taf long-term. The average annual SWP interruptible delivery in the dry period of 1928 through 1934 is 66 taf and 195 taf long-term. The average annual for CVP south-of-Delta delivery in the dry period of 1928 through 1934 is 1,560 taf and 2,147 taf long-term. The average annual CVP north-of-Delta delivery in the dry period of 1928 through 1934 is 2,059 taf and 2,249 taf long-term. The average annual CVP south-of-Delta agricultural delivery in the dry period of 1928 through 1934 is 241 taf and 667 taf long-term.

Figure V.1.1
Frequency of Total SWP south-of-Delta Firm Delivery Reliability

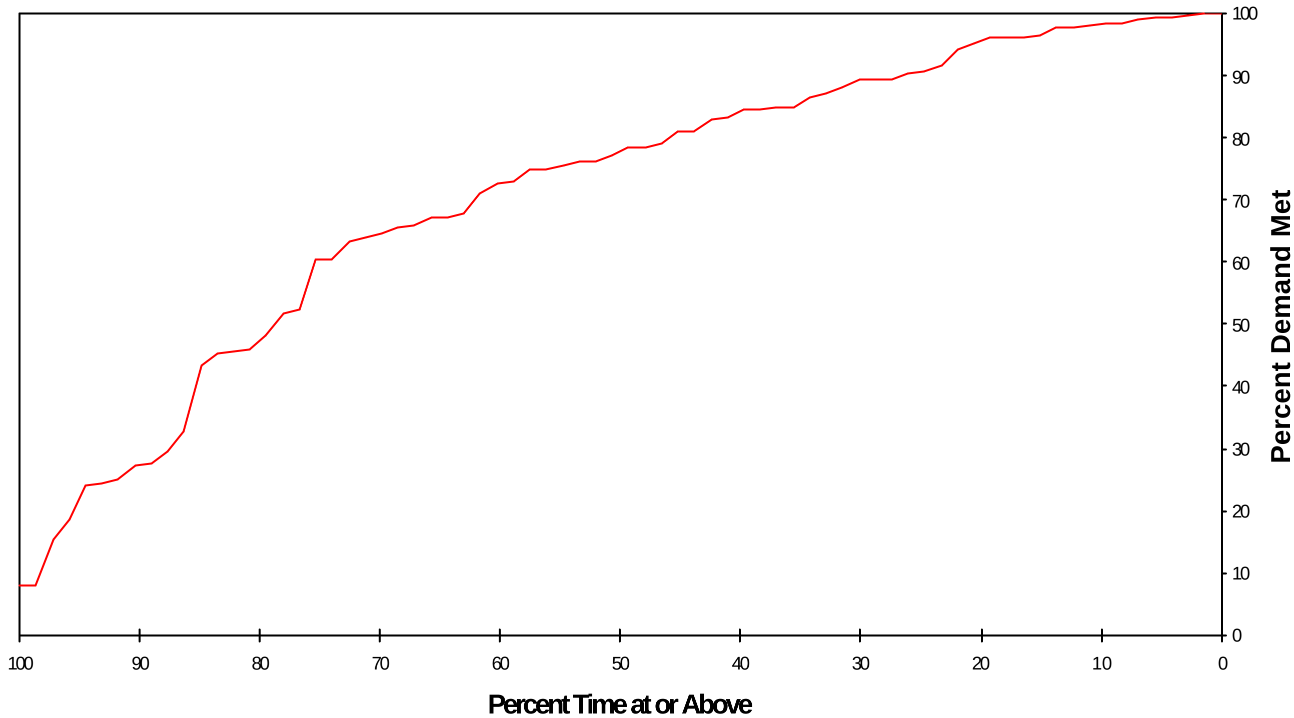


Figure V.1.1 shows the frequency of total annual SWP south-of-Delta firm delivery reliability. In 50 percent of the years, about 75 percent of the SWP south-of-Delta firm demand is met.

Figure V.1.2
Frequency of SWP Interruptible Delivery

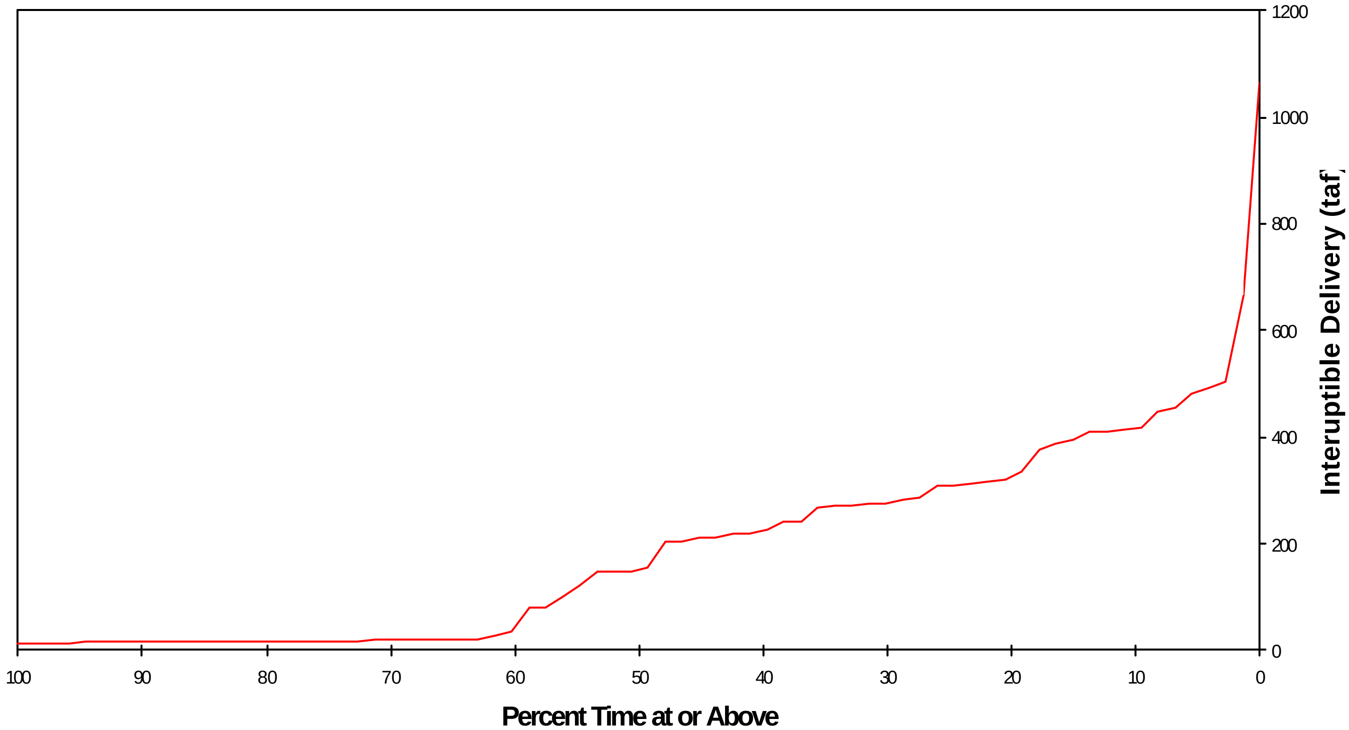


Figure V.1.2 shows the frequency of total annual SWP interruptible delivery. In about 50% of the years, the total annual interruptible delivery is at least 150 taf. The average annual interruptible delivery is 195 taf.

Figure V.1.3
Frequency of Total CVP south-of-Delta Delivery

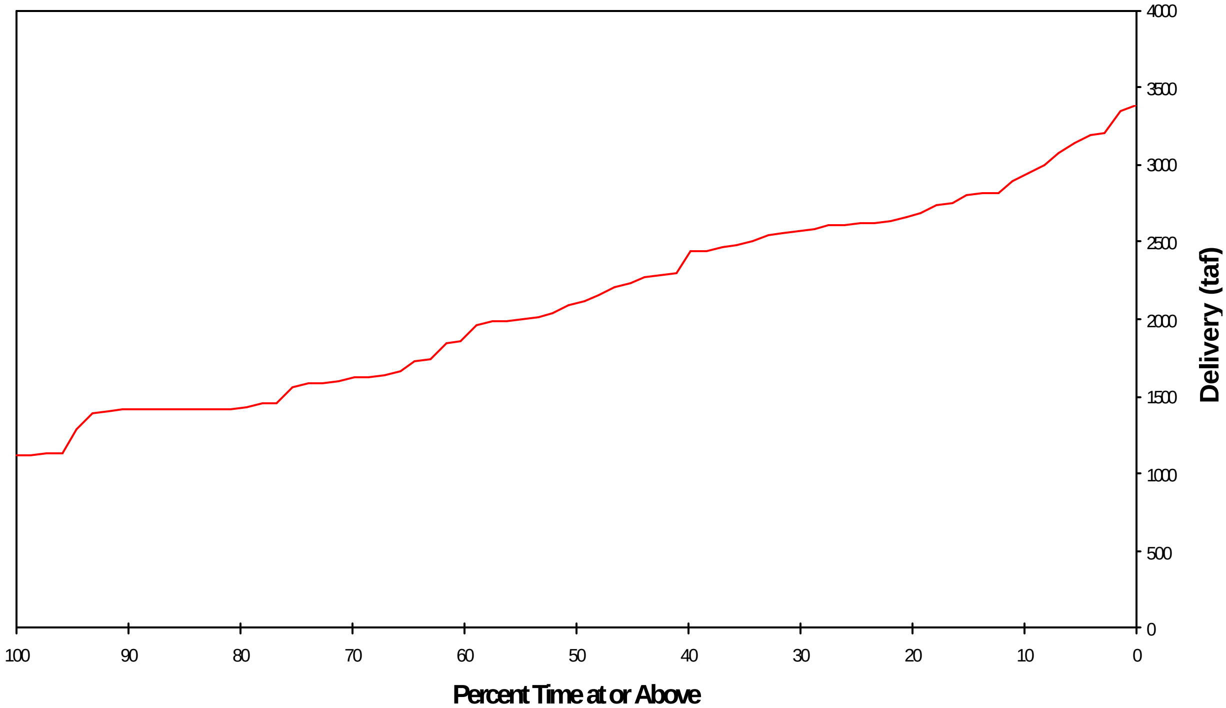


Figure V.1.3 shows the frequency of total annual CVP south-of-Delta delivery. In 50 percent of the years, the total annual CVP south-of-Delta delivery is at least 2,000 taf. The average annual CVP south-of-Delta delivery is 2,147 taf. In 50 percent of the years, the total annual CVP south-of-Delta agricultural delivery is at least 500 taf or 27 percent of the full allocation.

Figure V.1.4
Frequency of Total CVP south-of-Delta Agricultural Delivery

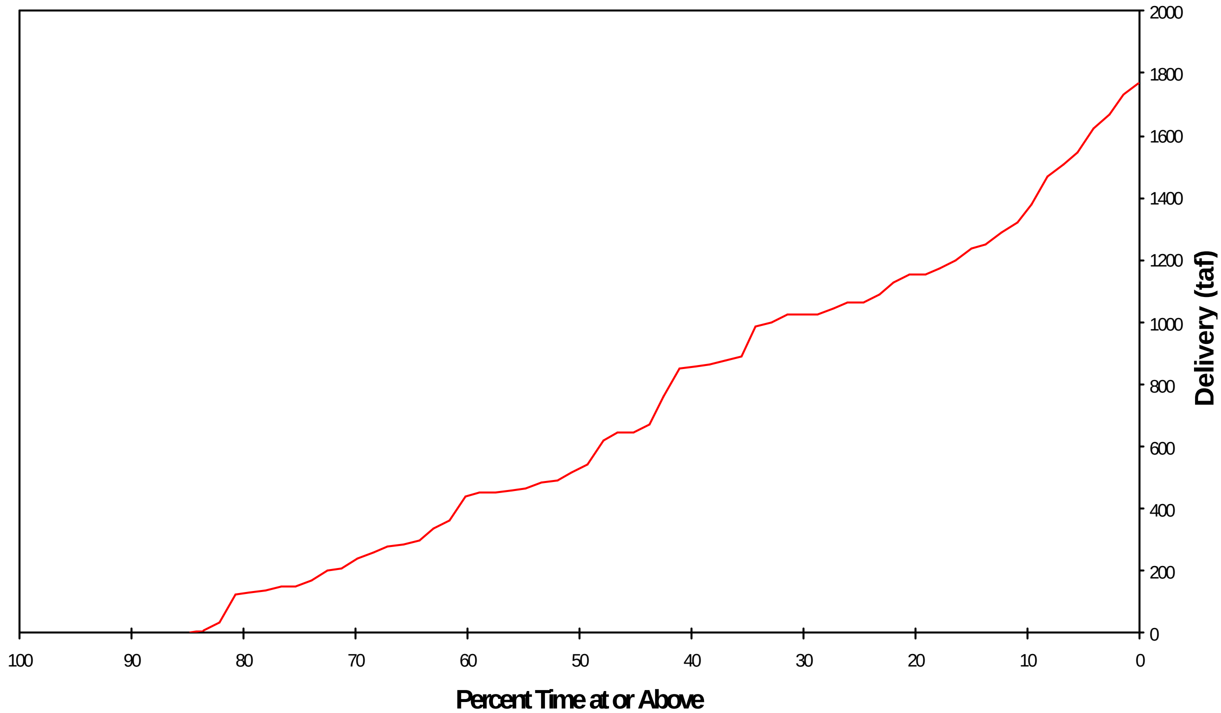


Figure V.1.4 shows the frequency of total CVP south-of-Delta delivery to agricultural contractors. In 50% of the years, the total annual CVP south-of-Delta delivery to agricultural contractors is at least 500 taf. The average annual CVP south-of-Delta delivery to agricultural contractors is 667 taf.

Figure V.1.5
Frequency of Total CVP north-of-Delta Delivery

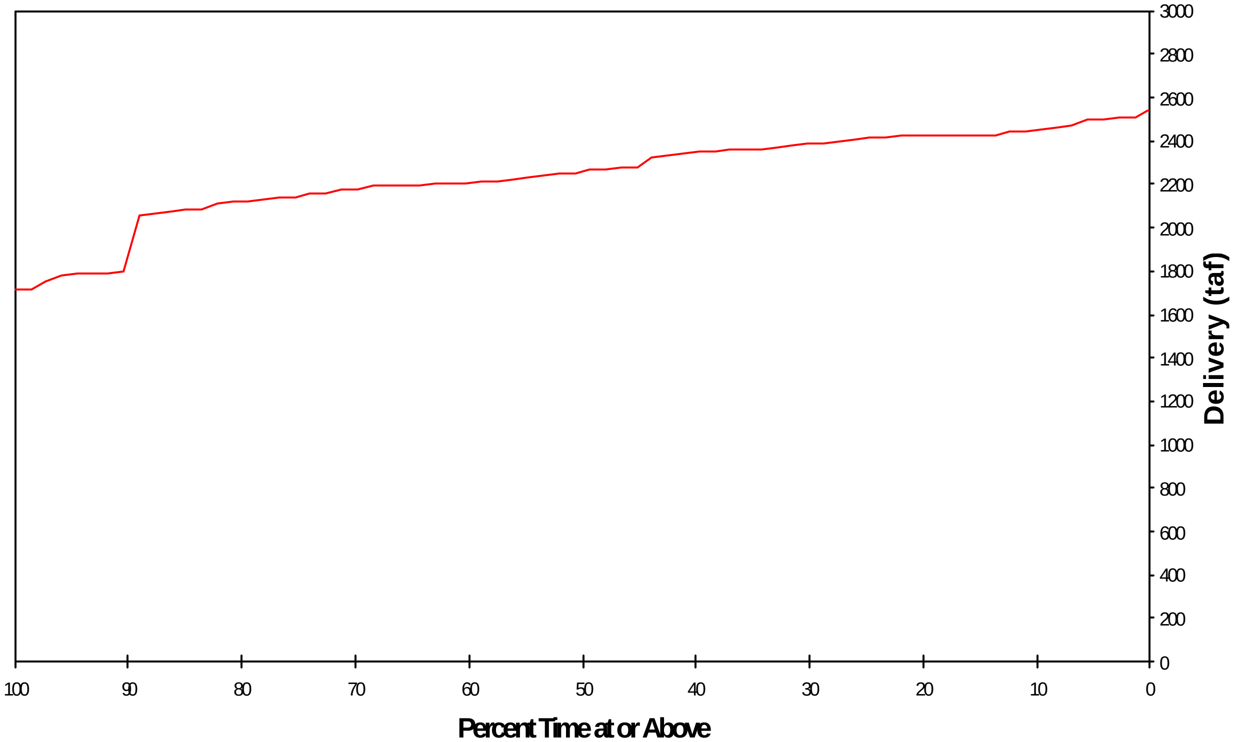


Figure V.1.5 shows the frequency of total CVP north-of-Delta delivery. In 50% of the years, the total annual CVP north-of-Delta delivery is at least 2,200 taf. The average annual CVP south-of-Delta delivery to agricultural contractors is 2,249 taf.

V.2. CVPIA (b)(2) Operations

Figure V.2.1
Total End of Year (b)(2) Costs

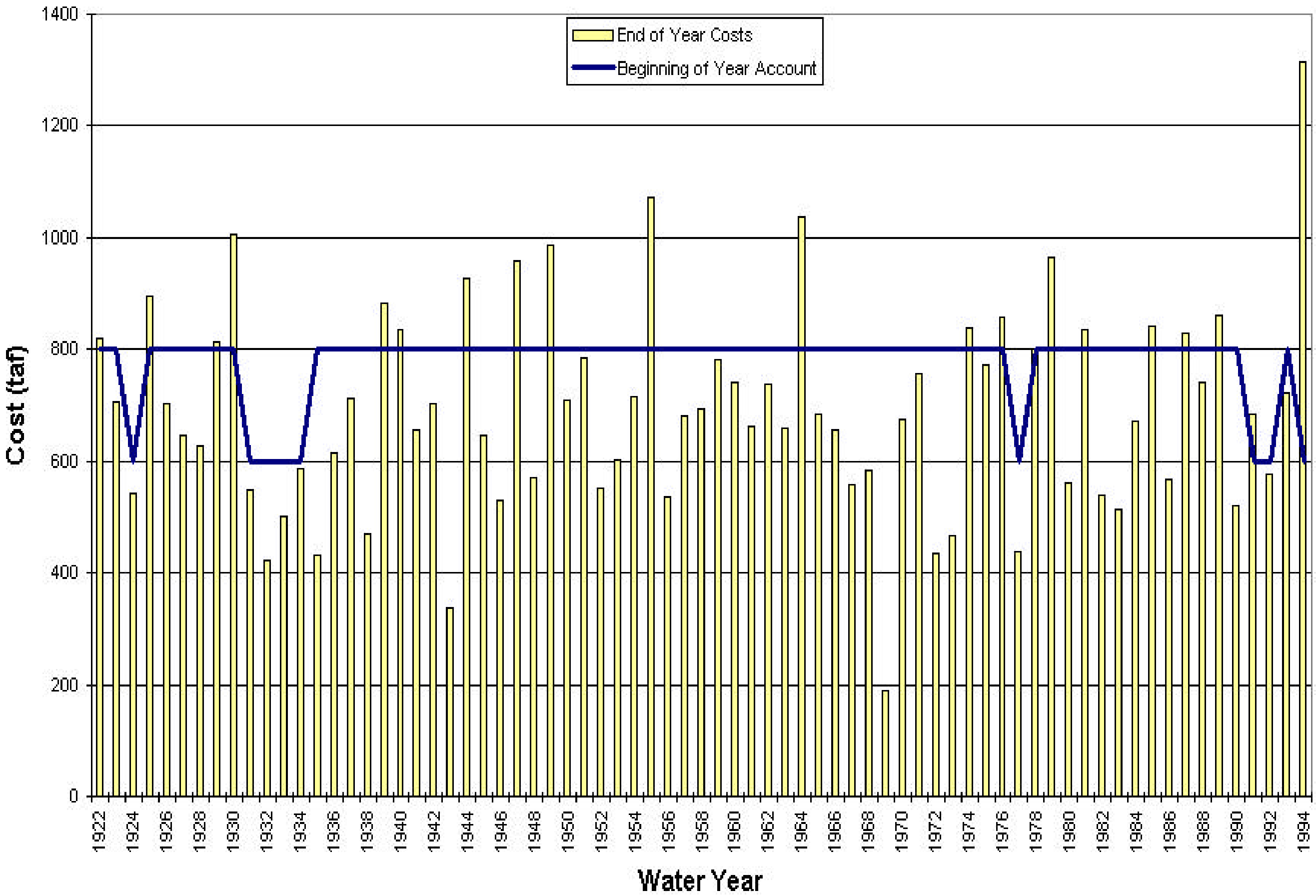


Figure V.2.1 shows the total end of year (b)(2) costs and the beginning of year (b)(2) account. The blue line shows the total (b)(2) account limit at the beginning of each year (800 taf in normal years, 600 taf in Shasta critical years). The bars show the actual total end of year (b)(2) costs for each year. There are seventeen years out of the 73-year study period in which the total (b)(2) cost exceeded the (b)(2) account. The total (b)(2) costs exceeded the (b)(2) account limit because of several reasons: 1. CALSIM is a monthly time-step model and will impose a (b)(2) action as long as there is a balance in the (b)(2) account at the beginning of the month. When a (b)(2) action is imposed, it is imposed for the entire month, and the action taken resulted in a cost more than the remaining (b)(2) account balance; 2. Export differences due to different operations in July through September period between the (b)(2) study and the WQCP study result in a (b)(2) cost even though no (b)(2) action is taken in the July through September window. Conversely, there are many years when the total (b)(2) cost is less than the (b)(2) account limit as shown in the chart. In those years, all of the eight (b)(2) actions are taken, but the total cost of those actions is less than 800 taf or 600 taf (b)(2) account. In these years, either the (b)(2) actions did not cost much or the WQCP cost is negative.

Figure V.2.2
Total Annual WQCP Costs

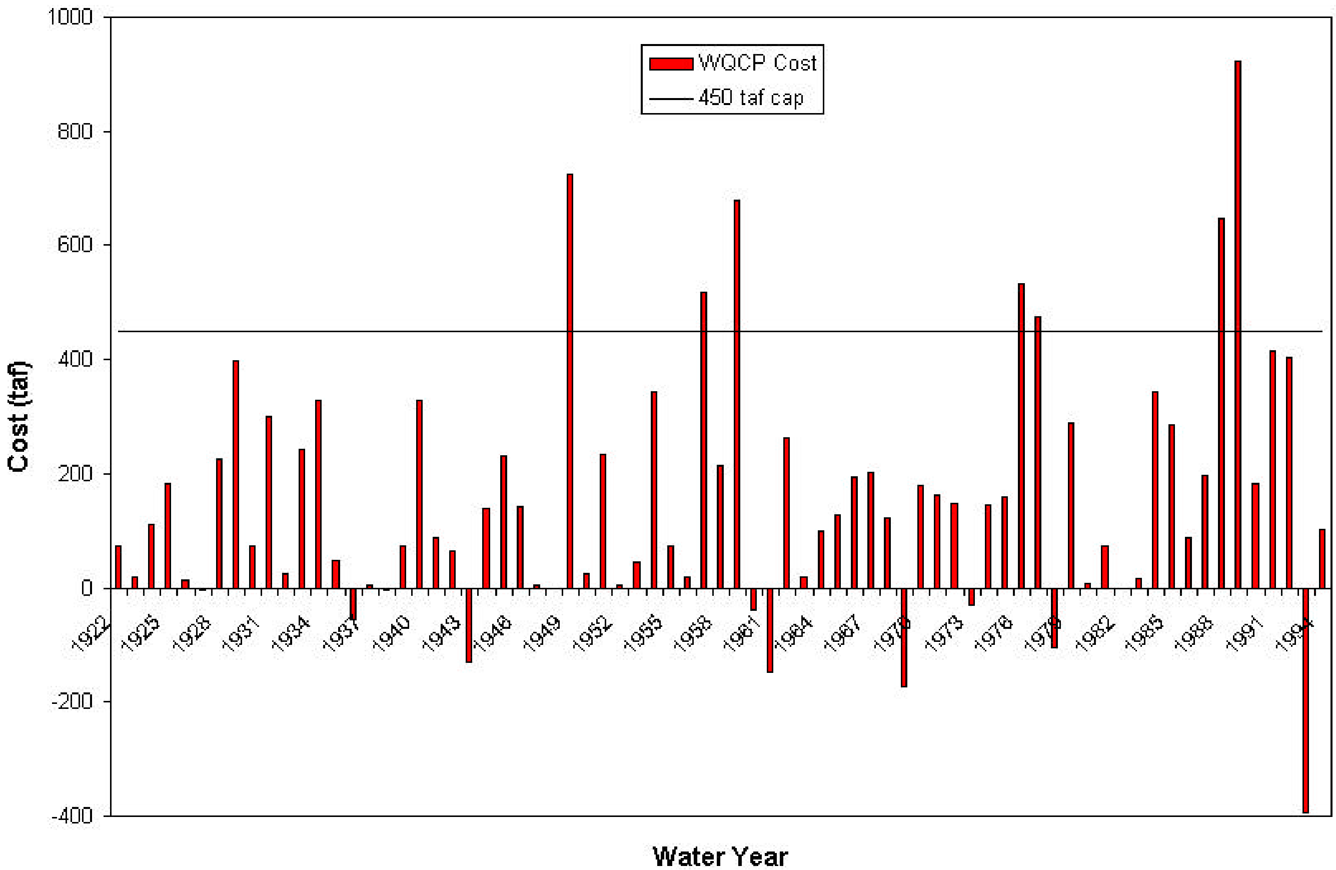


Figure V.2.2 shows the total annual CVP WQCP costs. This is the total cost to the CVP due to regulatory requirements of the WQCP. The cost is computed from the WQCP study with D1485 as the baseline. There are 7 years in which the WQCP costs exceeded the 450 taf cap. In the (b)(2) accounting procedure, only up to 450 taf of CVP WQCP cost provided to meet the WQCP requirements is charged to the (b)(2) account. There are fifteen years in which the WQCP cost is less than D1485 because of either differences in Delta outflow requirements, water-year type classifications, or export constraints.

Figure V.2.3
Percent of Time (b)(2) Actions Taken

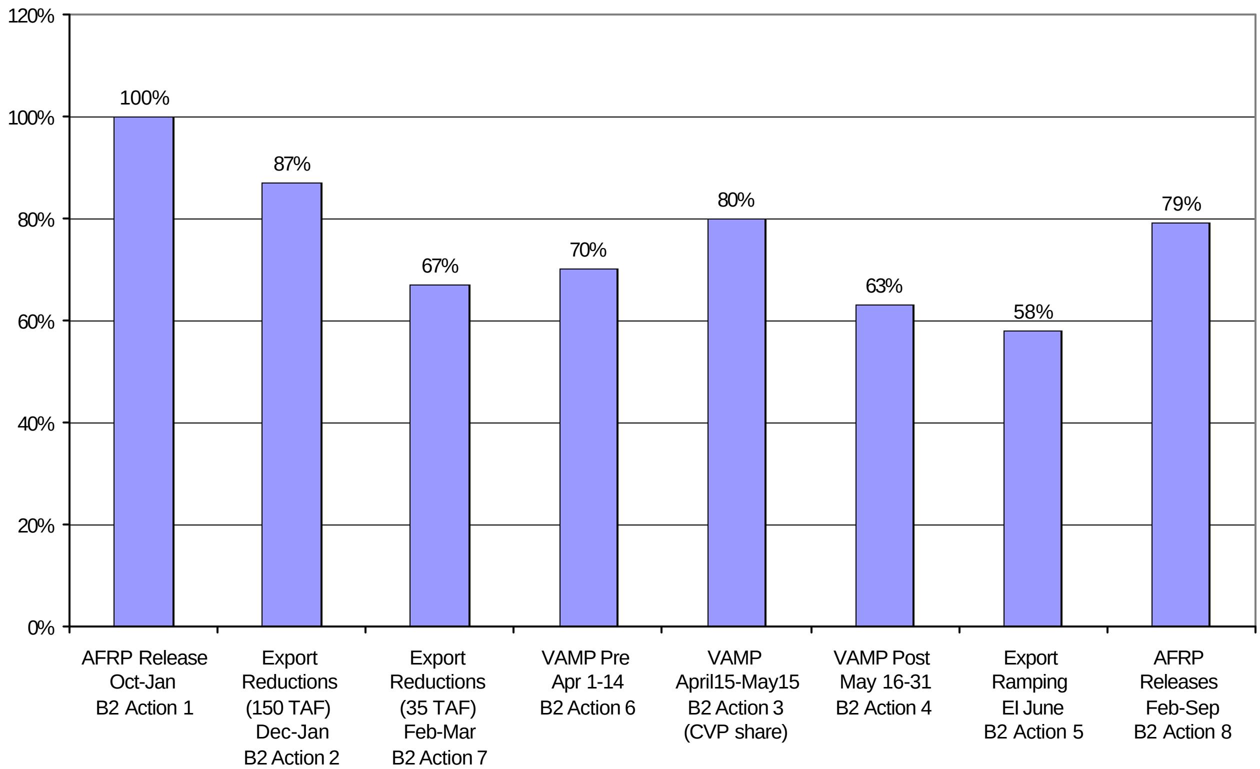


Figure V.2.3 shows the percent of time (b)(2) actions are taken for the 73-year study period. The (b)(2) actions are imposed on the CVP system only. The (b)(2) action that is most frequently taken is Action 1 (AFRP releases in October through January) at 100%. The second most frequently taken action is Action 2 (December and January export reductions) at 87%. The next most frequently taken action is Action 3 (VAMP) at 80%, followed by Action 8 (AFRP releases February through September) at 79%. The percent of times the remaining actions as follows: Action 4 (post-VAMP 16 through 31 May) at 63%, Action 5 (June EI ramping) at 58%, Action 6 (pre-VAMP 1 through 4 April) at 70%, and Action 7 (35 taf export reduction February and March) at 67%. The reason that Action 2 (December through January export reductions) is taken slightly more frequently than Action 3 (VAMP) is due to the reserve amounts used to trigger Action 2. The reserve amounts need to be refined so that there will be more (b)(2) water left to do Action 3 (VAMP).

V.3. EWA Operations

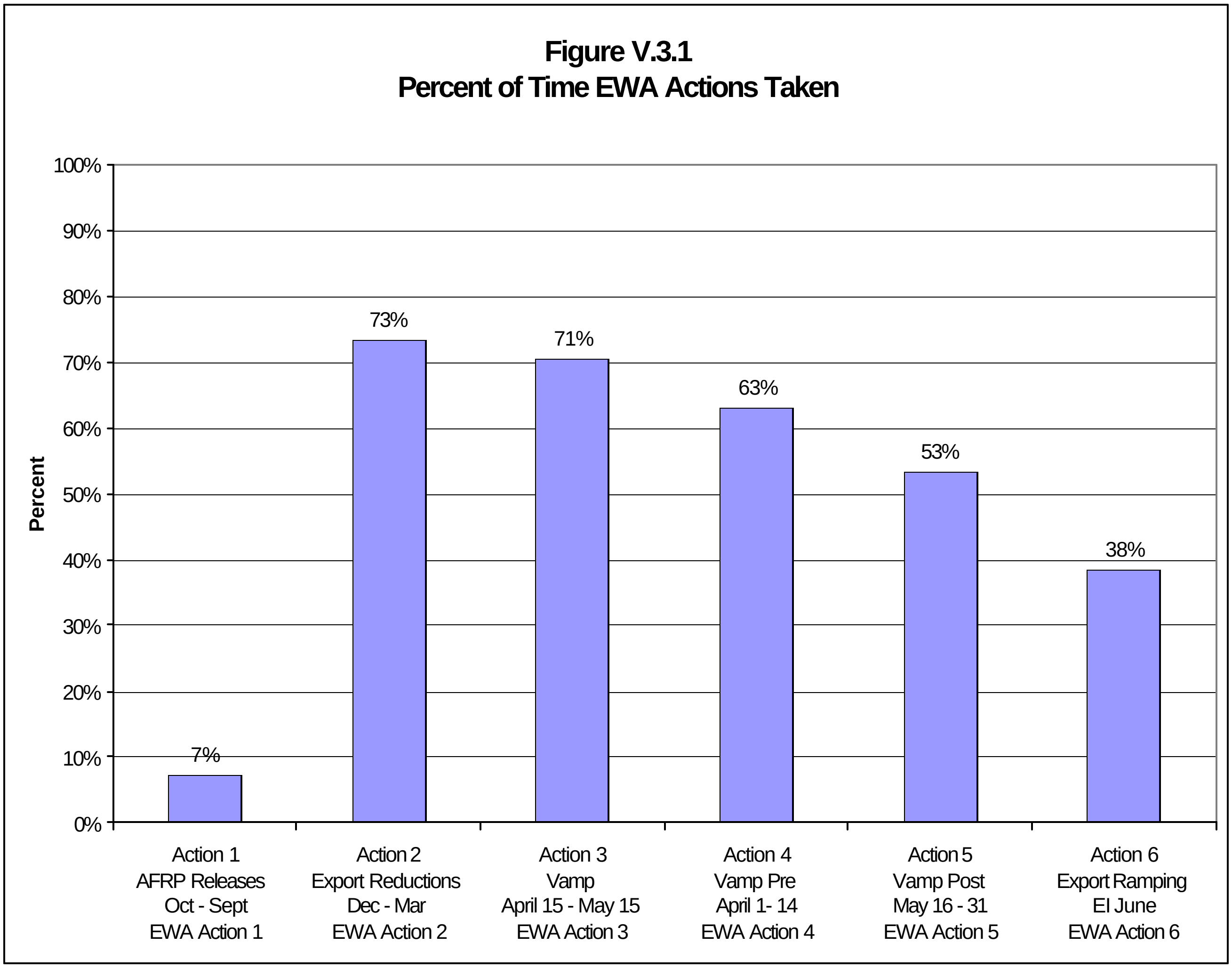


Figure V.3.1 shows the percent of time EWA actions are taken. While the (b)(2) actions are imposed only on the CVP system, EWA actions are imposed on both the SWP and CVP systems. Four of the EWA actions are the same as the (b)(2) actions. The EWA would impose actions only on the SWP if (b)(2) actions were imposed on the CVP. However, if (b)(2) actions were not imposed on the CVP because the (b)(2) account is exhausted, then the EWA will impose actions on both the CVP and SWP as long as the EWA has sufficient collateral to repay the debt to the projects. The EWA action most frequently taken is Action 2 (Dec-Mar export reduction) at 73% of the time. The next most frequently taken action is Actions 3 (VAMP) at 71% of the time, followed by Action 4 (pre-VAMP 1 through14 April) at 63% of the time. The percent of time the remaining EWA actions taken are as follows:

Action 5 (post-VAMP 16 through 31 May) at 53% of the time, Action 1 (AFRP releases October through September) at 7%, and Action 6 (June EI ramping) at 38% of the time.

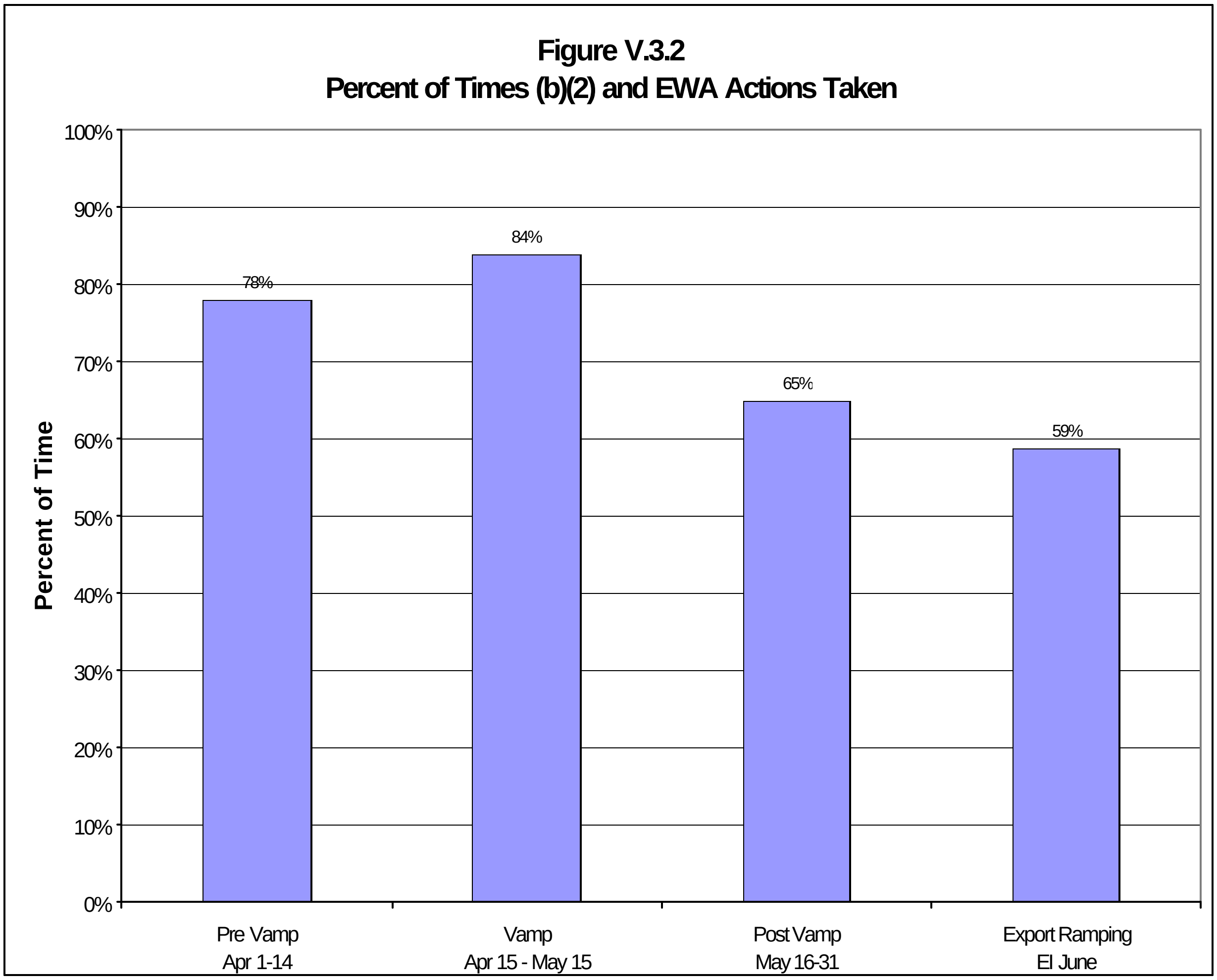


Figure V.3.2 shows the percent of time (b)(2) and EWA actions are taken. The actions are common to (b)(2) and EWA. These are percent of times when:

- (b)(2) actions are taken on the CVP, and EWA actions are taken on the SWP (this qualifies as one full action taken)
- no (b)(2) action is taken on the CVP, but EWA actions are taken on both the SWP and CVP (this qualifies as one full action taken)
- or (b)(2) actions are taken on the CVP, and EWA does not take actions (this qualifies as one half action taken)

The most frequently taken (b)(2)/EWA action is VAMP at 84% of the time. The next most frequently action taken is pre-VAMP at 78% of the time, followed by post-VAMP at 65% of the time, and June EI export ramping at 59% of the time.

Figure V.3.3
Frequency of Joint Point Use for EWA
(Includes 500 cfs July through September)

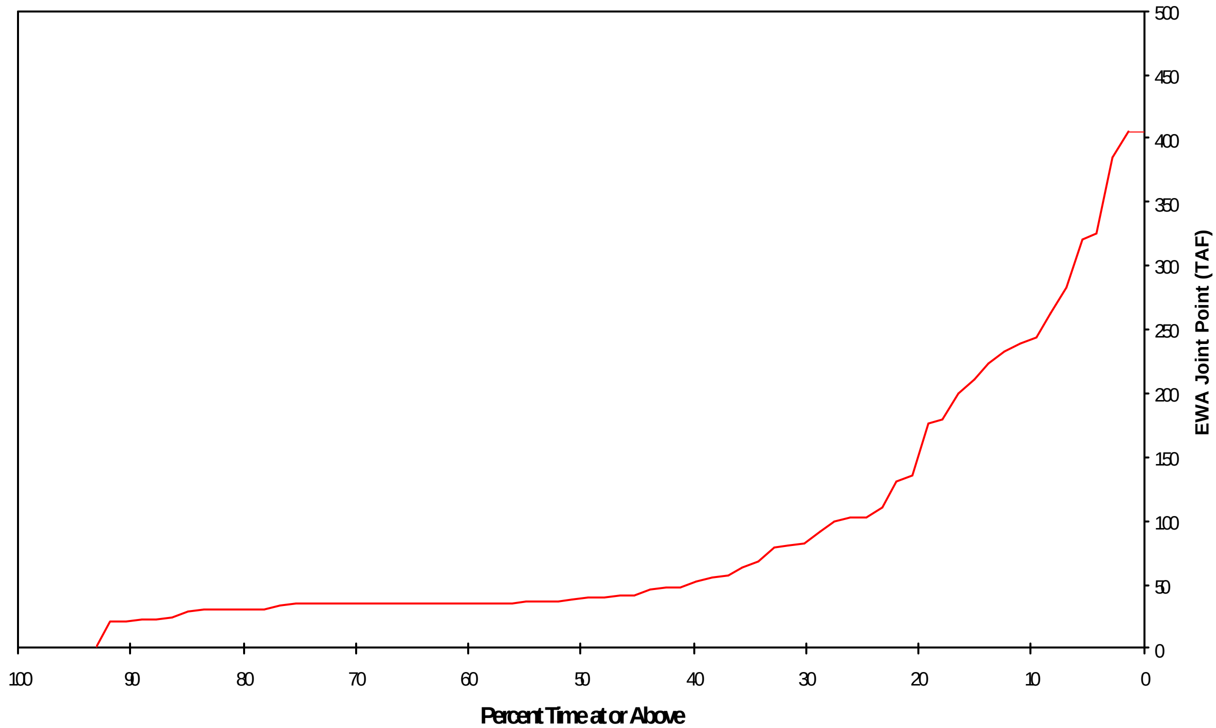


Figure V.3.3 shows the frequency of total annual use of joint-point-of-diversion for the EWA. This represents the total use of joint-point-of-diversion at Banks Pumping Plant to export water for the EWA, including a north-of-Delta purchase, EWA water stored in north-of-Delta project reservoirs, and surplus water. The average annual total use of joint-point-of-diversion for the EWA is 86 taf.

Figure V.3.4
EWA Use of 500 cfs Joint Point capacity in July through September

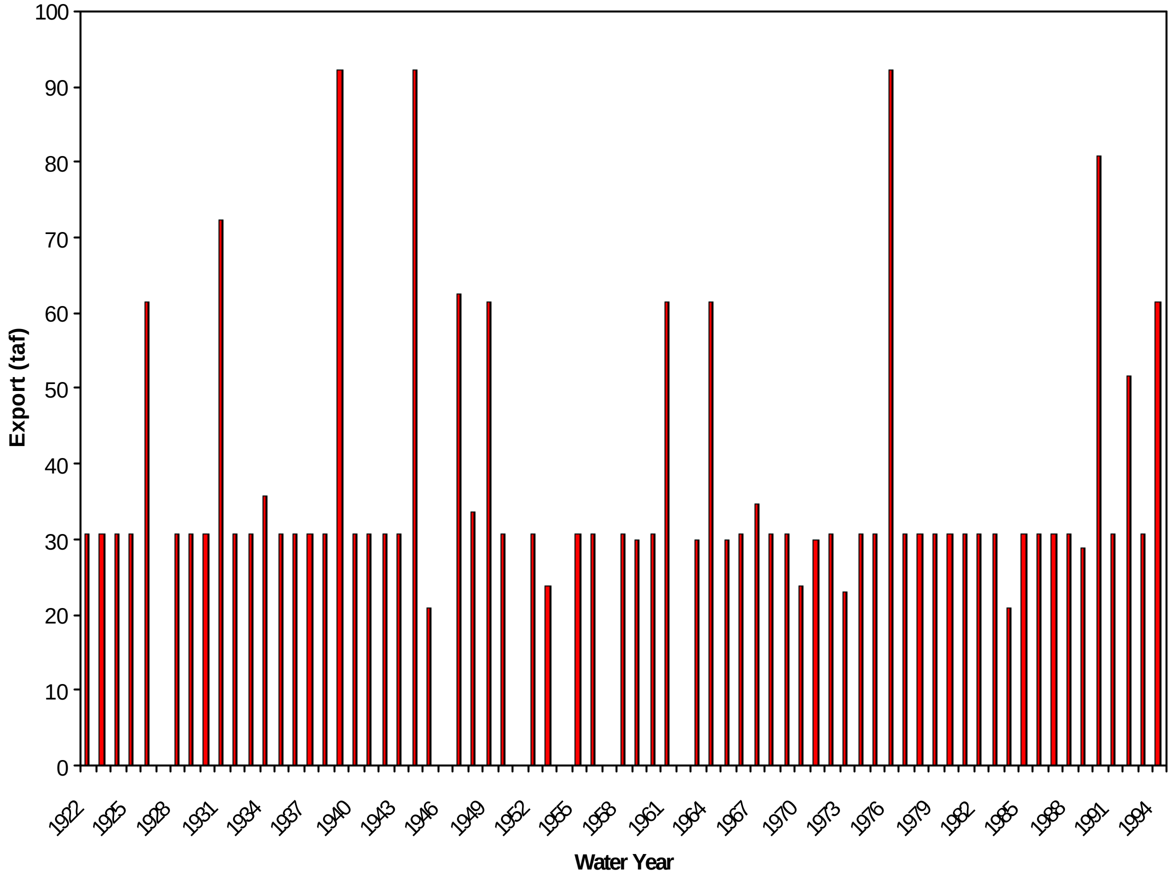


Figure V.3.4 shows total use of 500 cfs additional Banks Pumping Plant capacity in July through September by the EWA to transfer water. There are 3 years in which the EWA uses the full 500 cfs additional Banks Pumping Plant. Most of time, however, the EWA does not use the full 500 cfs additional Banks Pumping Plant capacity in all three months because it does not have water to transfer. Typically, the EWA uses the 500 cfs capacity to transfer the 35 taf north-of-Delta purchase and EWA water stored in northern project reservoirs. The average annual EWA usage of the additional 500 cfs Banks Pumping Plant capacity is 34 taf.

Figure V.3.5
EWA Use of Joint Point toTransfer north-of-Delta Storage

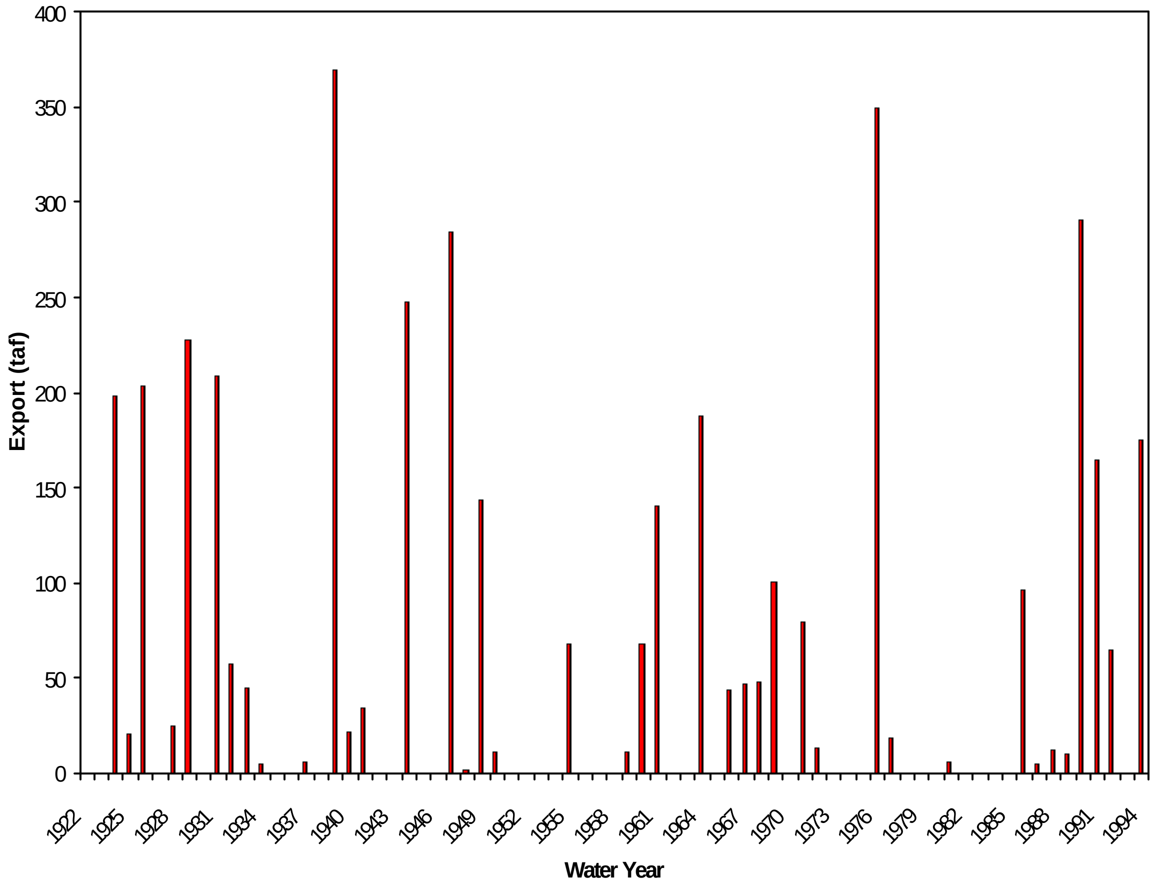


Figure V.3.5 shows total annual transfer of EWA water from north-of-Delta EWA storage into San Luis Reservoir through the use of joint-point-of-diversion through Banks Pumping Plant. When the EWA takes an action to reduce exports, the amount of storage backed up in Lake Oroville, Shasta Lake, or Folsom Lake as a result of EWA imposed export reduction is credited to the EWA account in those reservoirs. The transfer of EWA water from the northern reservoirs is prevalent in dry years because

- EWA storage in northern reservoirs is usually higher in dry years because EWA is less likely to lose its storage account due to flood control spills.
- There is plenty of joint-point-of-diversion capacity available at Banks Pumping Plant to transfer EWA water in dry years

The average annual transfer of EWA water from north-of-Delta reservoirs to San Luis reservoir is 56 taf.

Figure V.3.6
EWA Assets Utilized

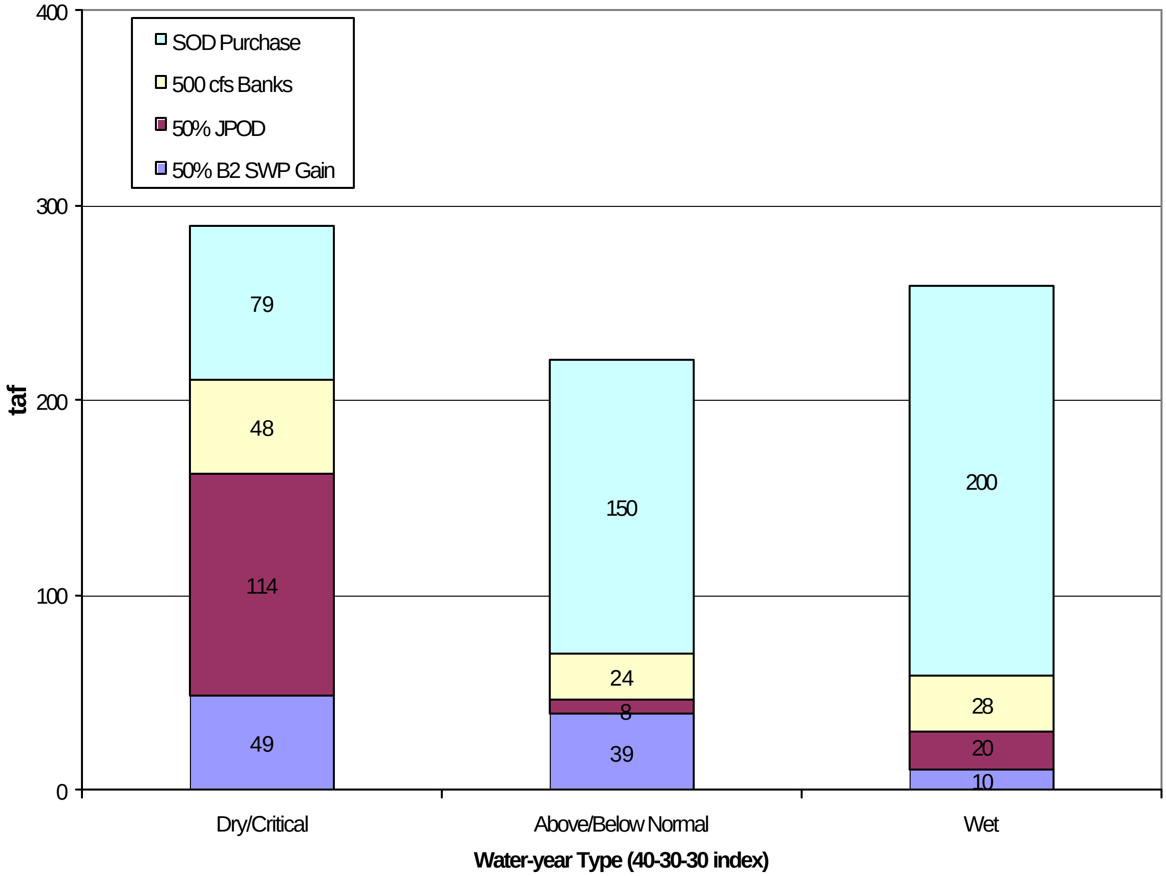


Figure V.3.6 shows EWA assets utilized by water-year type. The assets shown include south-of-Delta purchase, 500 cfs additional Banks Pumping Plant capacity, 50% of joint-point-of-diversion capability, and 50% of (b)(2) SWP gain. The average asset from south-of-Delta purchase is 79 taf/year in dry and critical years, 150 taf/year in above and below normal years, and 200 taf/year in wet years. The average asset from 500 cfs additional Banks Pumping Plant capacity is 48 taf/year in dry and critical years, 24 taf/year in above and below normal years, and 28 taf/year in wet years. The average asset from 50% of joint point of diversion capability is 114 taf/year in dry and critical years, 8 taf/year in above and below normal years, and 20 taf/year in wet years. The average asset from 50% of (b)(2) SWP gain is 49 taf/year in dry and critical years, 39 taf/year in above and below normal years, and 10 taf/year in wet years. These are the major assets that the EWA utilizes to accumulate collateral south-of-Delta so that it can repay debt to the projects when it imposes an EWA action. The 50% of (b)(2) SWP gain and 50% of joint-point-of-diversion may be overestimated because export at Banks Pumping Plant was allowed to increase above the WQCP baseline when a (b)(2) action was imposed.

Figure V.3.7
Unpaid EWA Debt

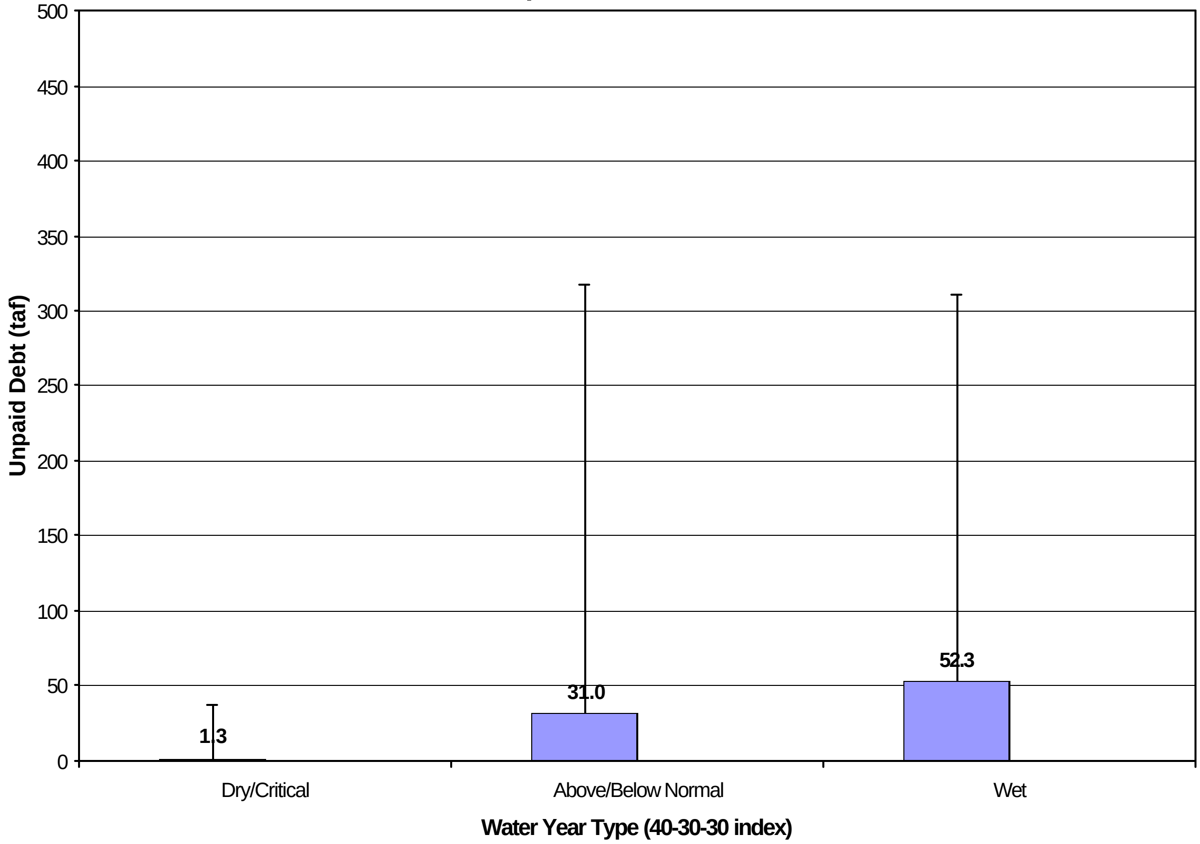


Figure V.3.7 shows the EWA average unpaid debt by water-year type. The bars show the maximum unpaid debt by water-year type. In CALSIM, all EWA debts are repaid to the projects by the end of the water year; the amount of debt that the EWA did not have enough collateral to repay is labeled "unpaid" debt. In actual operations, the EWA could carry the debt to the following year. In the modeling study, this debt was assumed to be paid from an unspecified source. Currently in CALSIM, EWA debt is not carried to the following year. The average annual EWA unpaid debts are 1.3 taf in dry and critical years, 31 taf in above and below normal years, and 52.3 taf in wet years.

Figure V.3.8
EWA south-of-Delta Purchase

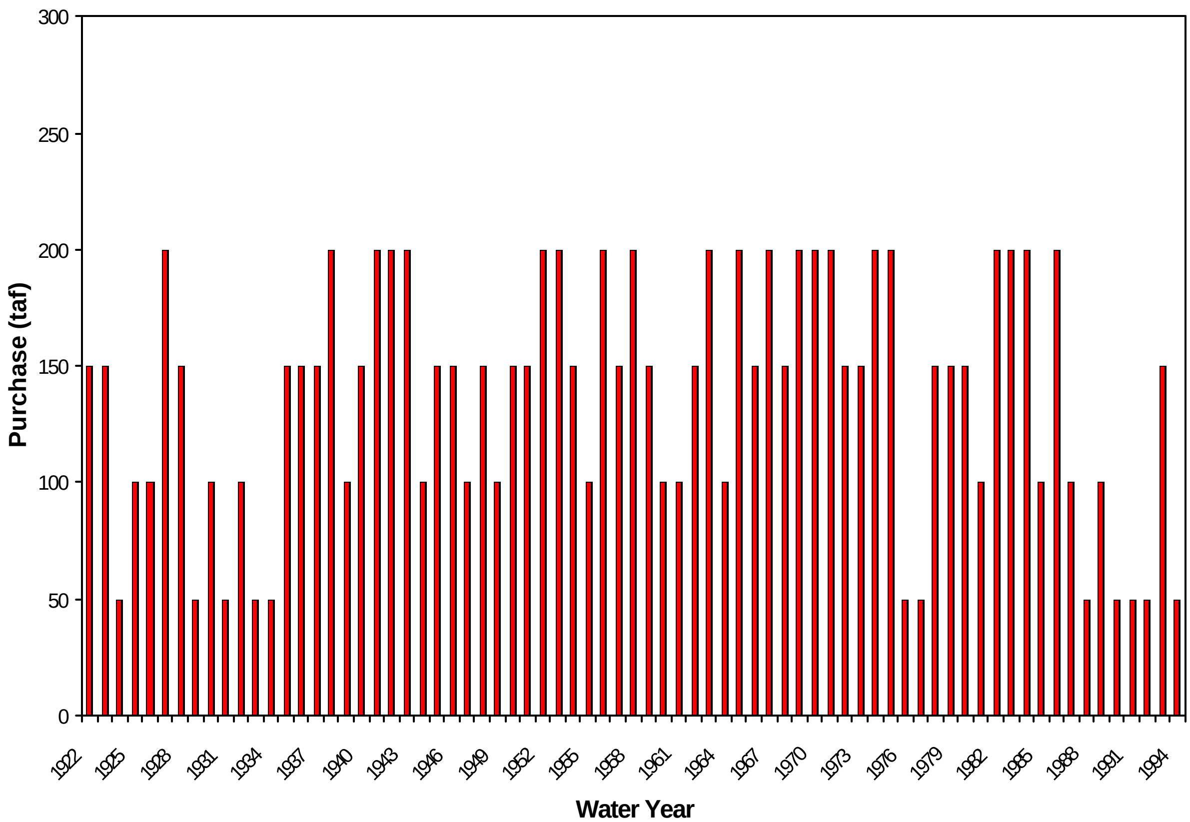


Figure V.3.8 shows EWA south-of-Delta purchase. The purchase amounts are 50 taf/year in critical years, 100 taf/year in dry years, 150 taf/year in above and below normal years, and 200 taf/year in wet years. The EWA uses the purchase water to repay debts to the projects.

Figure V.3.9
EWA Storage in San Luis Reservoir

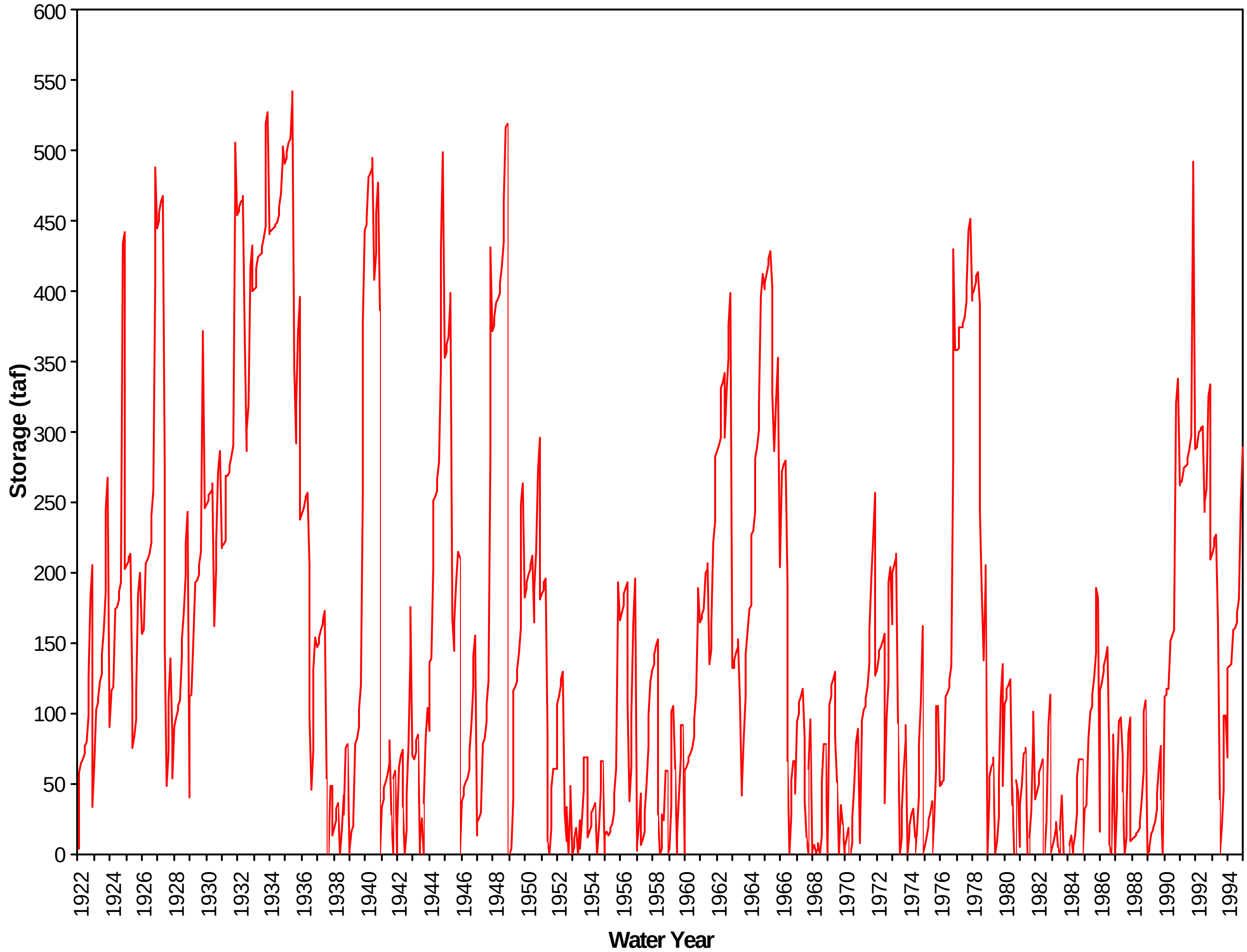


Figure V.3.9 shows EWA San Luis storage. This is EWA's storage account in San Luis Reservoir. This is a part of the south-of-Delta EWA collateral that the EWA accumulates from the various assets. The collateral is used to repay EWA debts to the projects when EWA incurs a debt on the projects by taking an EWA action. EWA will lose its storage in San Luis reservoir if storage is filled. EWA storage is usually high in dry years because:

- During dry years, EWA actions do not cost as much water because baseline deliveries are low. Therefore, EWA does not have much debt to repay to the projects.
- San Luis reservoir has storage capacity available for EWA to store its water. EWA San Luis reservoir does not spill for several consecutive years.
- In dry years, EWA has more opportunity to back up water in Lake Oroville, Shasta Lake, and Folsom Lake because there is less chance of losing that water due to flood control spills from the reservoirs.
- There is plenty of joint-point-of-diversion capacity available at Banks Pumping Plant.

V.4. Trinity River

Figure V.4.1

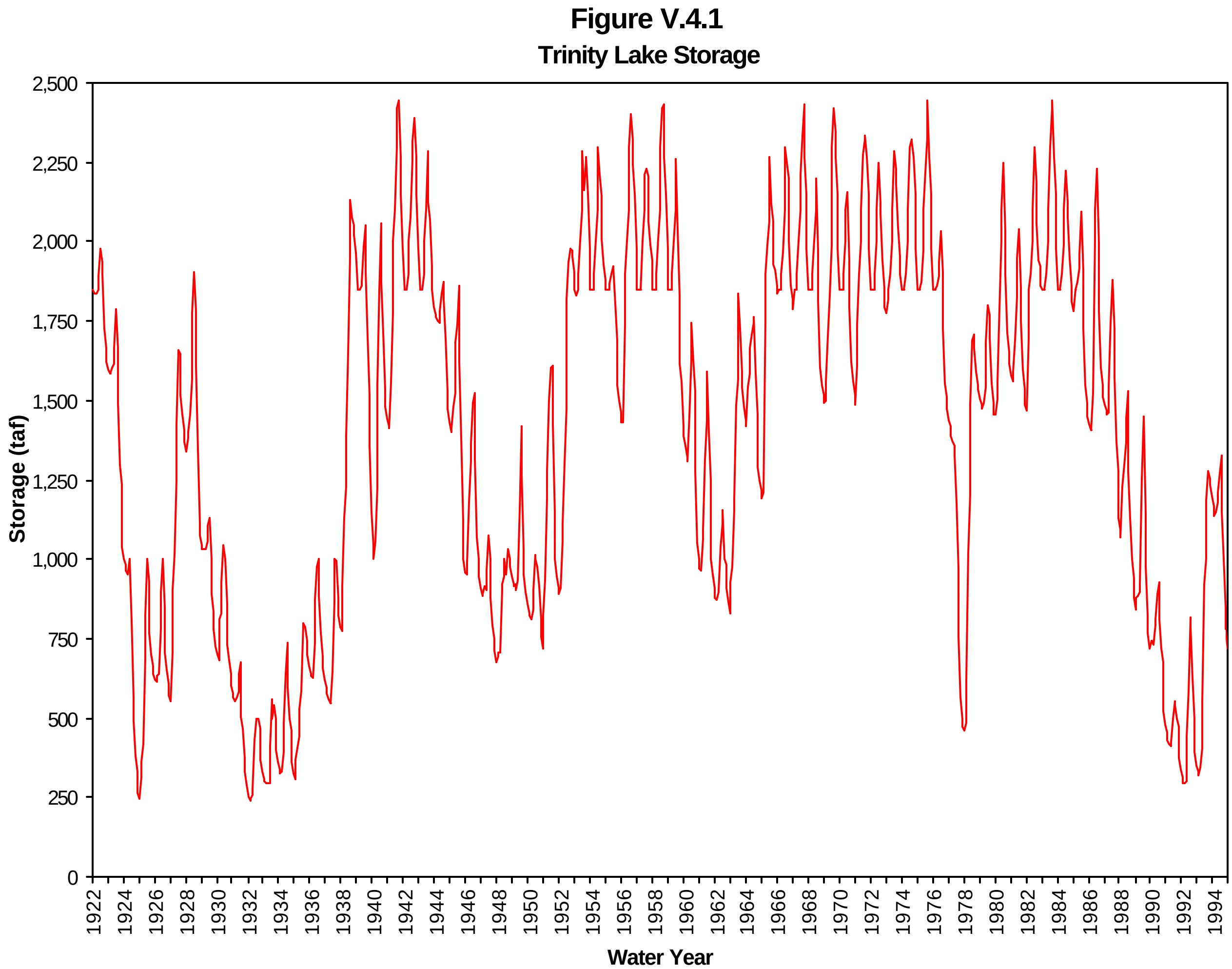


Figure V.4.1 shows Trinity Lake storage. The reservoir is operated to meet the Trinity River minimum required flow and export of water to the Sacramento River system.

Figure V.4.2
Total Annual Trinity River Minimum Instream Flow

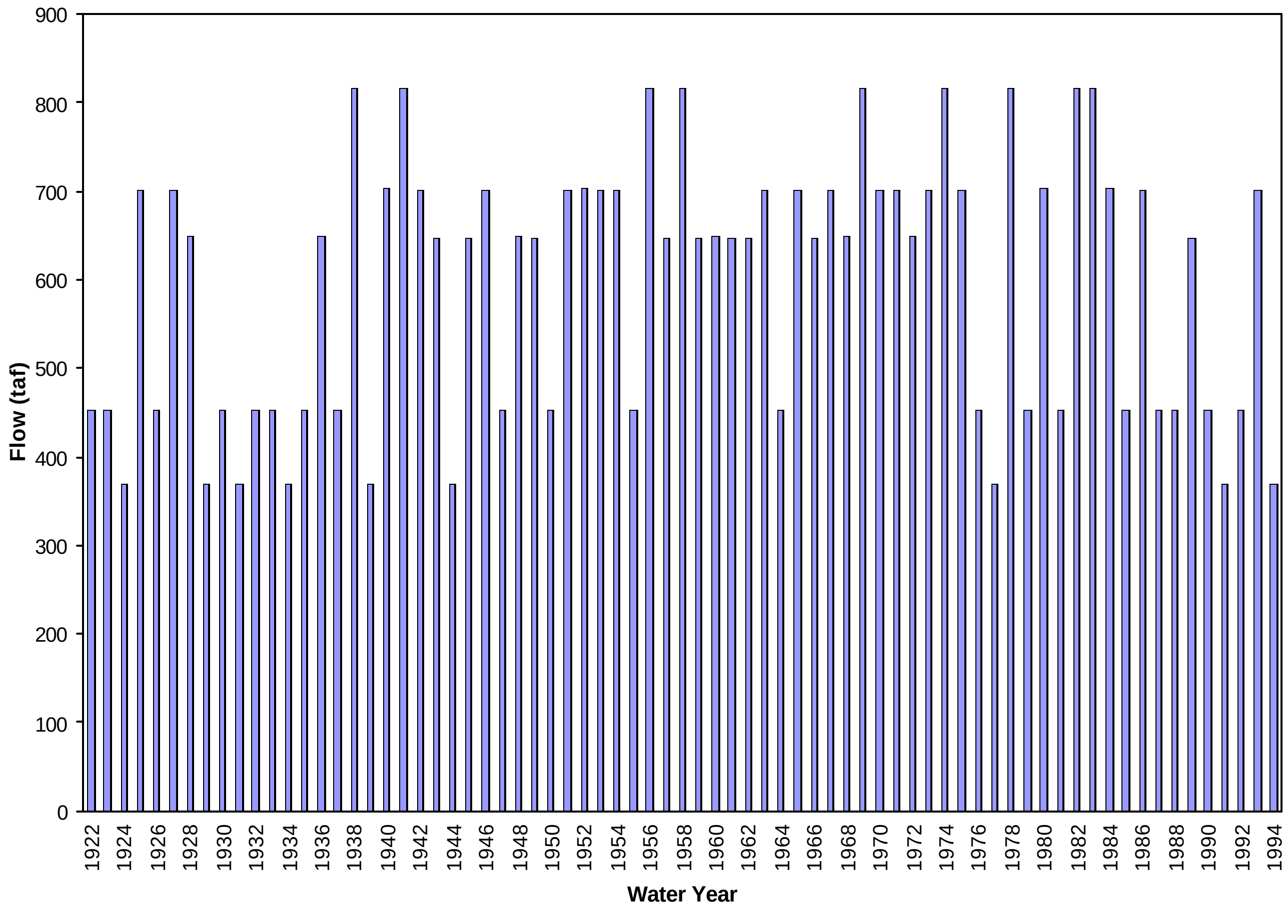


Figure V.4.2 shows the total annual Trinity River minimum instream flow for all years. The flows varied from 369 taf/year in dry years to 815 taf/year in wet years, based on the Trinity River index.

Figure V.4.3
Total Annual Trinity River Export

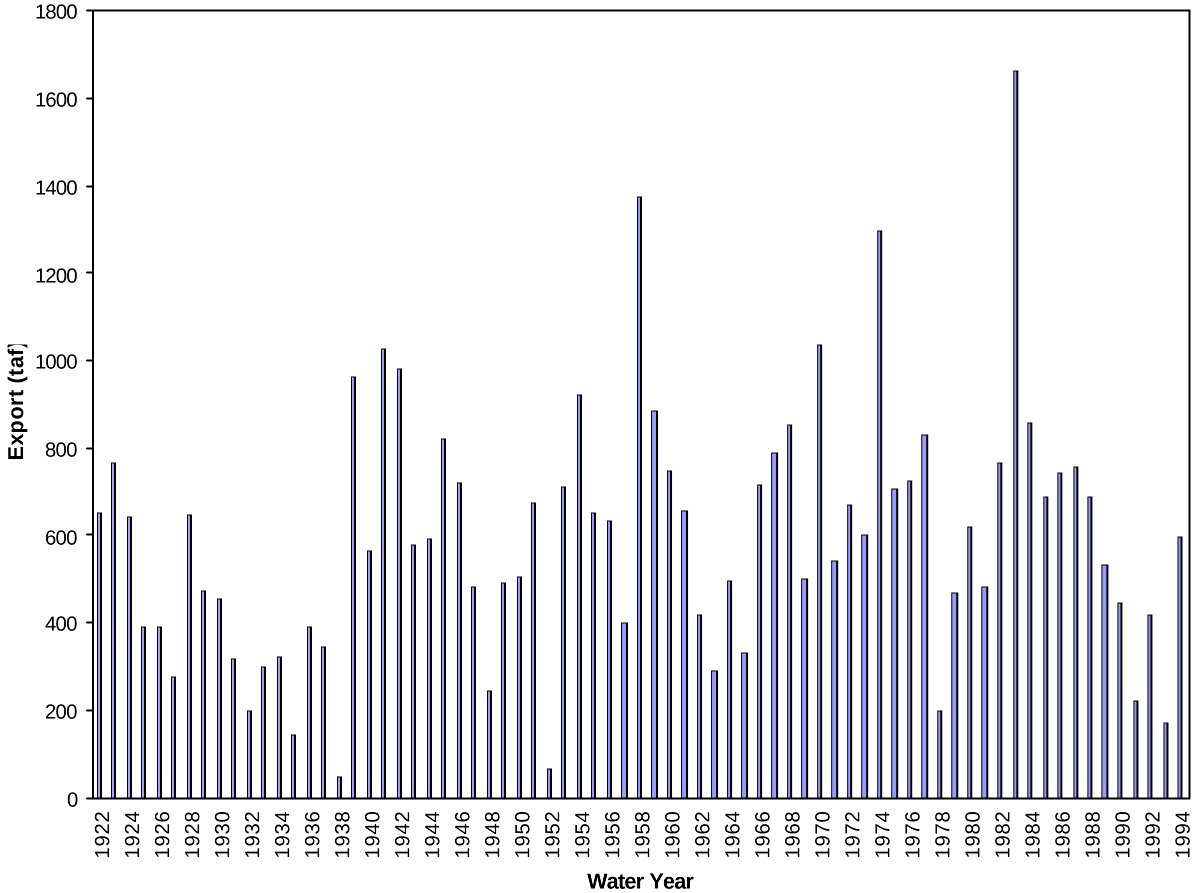


Figure V.4.3 shows the total Trinity River water exported annually to the Sacramento River system. The average annual export is about 598 taf.

V.5. Sacramento River

Figure V.5.1
Shasta Lake Storage

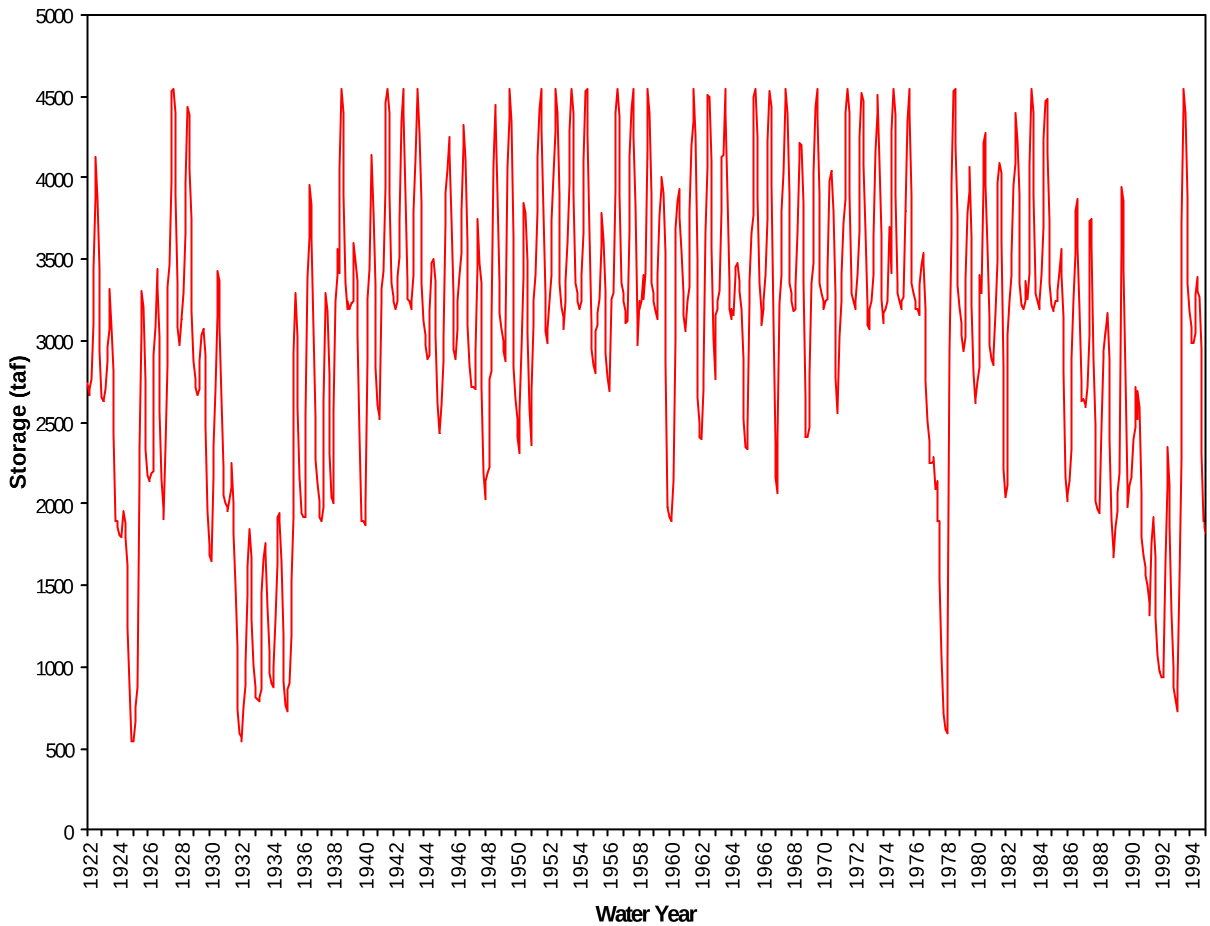


Figure V.5.1 shows Shasta Lake storage. There are 12 years in which the Shasta Lake carryover storage is lower than 1.9 maf. In four of those years, the carryover storage is between 1,600 and 1,850 taf, and in 8 of those years, the carryover storage is between 550 and 980 taf. Most of the low carryover storage occurs in dry years including 1924, the 1928 through 1934 dry period, 1977, and the 1986 through 1992 dry period. In those dry years, Shasta reservoir is operated mostly to meet AFRP or temperature control flows at Keswick Dam or navigational control flow requirements. The CVP Settlement Contractors (full allocation 2.2 maf/year, are assumed to use their entire yearly allocation, whether full or 25% deficiency. This is a conservative approach that aggravates the low Shasta carryover problem in this simulation. Also, it is certain that NMFS and Reclamation would develop extraordinary measures to avoid carryover as low as is shown here in the dry years, but it is not possible to simulate this adaptive management with this version of CALSIM.

Table V.5.1
Shasta Lake Release Control

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Storage
1922	Other	Other	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	2652
1923	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	Other	NCP	1900
1924	NCP	Keswick	Keswick	Keswick	Keswick	Other	NCP	NCP	NCP	NCP	NCP	NCP	560
1925	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Keswick	NCP	NCP	Other	NCP	Keswick	2173
1926	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	1968
1927	Other	Keswick	Keswick	Keswick	Other	Keswick	Other	Other	NCP	NCP	Other	NCP	3087
1928	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Keswick	Keswick	NCP	NCP	Other	Other	2878
1929	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	Other	NCP	1763
1930	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	Keswick	2052
1931	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Other	NCP	NCP	NCP	NCP	NCP	596
1932	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	Other	NCP	NCP	870
1933	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	NCP	NCP	968
1934	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	Other	NCP	NCP	765
1935	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	Other	1956
1936	NCP	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	2280
1937	NCP	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	2041
1938	NCP	Keswick	Other	Other	Other	Other	Other	Other	Other	Other	Other	NCP	3193
1939	Keswick	Other	Keswick	Keswick	Keswick	Other	NCP	NCP	Other	Other	Other	NCP	1900
1940	Other	Keswick	Keswick	Keswick	Other	Other	Keswick	Keswick	NCP	NCP	NCP	NCP	2609
1941	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	NCP	3273
1942	Other	Other	Other	Other	Other	Keswick	Keswick	Other	Other	Other	Other	NCP	3261
1943	Other	Other	Other	Other	Other	Other	Keswick	Keswick	NCP	NCP	Other	NCP	3119
1944	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	Keswick	NCP	NCP	NCP	NCP	2441
1945	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Other	2949
1946	Other	Keswick	Other	Other	Keswick	Keswick	NCP	NCP	NCP	NCP	Other	Other	2849
1947	Other	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	Other	Other	Other	Keswick	2026
1948	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Other	Other	Keswick	3170
1949	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Keswick	Keswick	NCP	Other	Other	NCP	2660
1950	Other	Other	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	NCP	NCP	NCP	2367
1951	Keswick	Keswick	Other	Other	Other	Keswick	NCP	Keswick	NCP	NCP	NCP	NCP	3065
1952	Keswick	Keswick	Other	Other	Other	Other	Other	Other	Keswick	Other	Other	Keswick	3206
1953	Keswick	Keswick	Other	Other	Keswick	Keswick	Keswick	Keswick	Other	Other	Other	Other	3300
1954	Other	Other	Other	Other	Other	Other	Other	Other	NCP	Other	Other	NCP	2945
1955	Other	Other	Keswick	Keswick	Other	Keswick	Keswick	Keswick	NCP	Other	Other	Keswick	2774
1956	Other	Keswick	Other	Other	Other	Keswick	Keswick	Other	Keswick	Other	Other	Other	3300
1957	Other	Keswick	Keswick	Keswick	Other	Other	Keswick	Other	NCP	NCP	Other	Other	2975
1958	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	3300
1959	Other	Keswick	Keswick	Other	Other	Other	NCP	NCP	Other	Other	Other	Other	1978
1960	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Keswick	3164
1961	Keswick	Keswick	Other	Keswick	Other	Keswick	Other	Keswick	Other	Other	Other	Keswick	2499
1962	Other	Other	Keswick	Keswick	Other	Keswick	Keswick	NCP	NCP	NCP	Other	Other	2766
1963	Keswick	Keswick	Other	Keswick	Other	Keswick	Other	Keswick	NCP	Other	Other	Keswick	3195
1964	Keswick	Other	Keswick	Other	Keswick	Keswick	NCP	NCP	NCP	NCP	NCP	Keswick	2352
1965	Other	Keswick	Other	Other	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	NCP	3185
1966	Keswick	Other	Other	Other	Keswick	Other	Other	NCP	NCP	Other	Other	Other	2159
1967	NCP	Keswick	Keswick	Other	Other	Other	Other	Other	Other	Other	Other	Other	3300
1968	Other	Keswick	Keswick	Keswick	Other	Keswick	NCP	Keswick	NCP	Other	Other	Other	2416
1969	Other	Keswick	Keswick	Other	Other	Other	Other	Other	NCP	Other	Other	Other	3300
1970	Other	Keswick	Other	Other	Other	Keswick	NCP	Keswick	NCP	Other	Other	Other	2568
1971	Other	Keswick	Other	Other	Keswick	Other	Keswick	Other	Other	Other	Other	Other	3300
1972	Other	Other	Other	Other	Keswick	Other	NCP	Keswick	NCP	NCP	Other	Keswick	3092
1973	Keswick	Other	Other	Other	Other	Other	Keswick	Keswick	NCP	NCP	NCP	Keswick	3111
1974	Keswick	Other	Other	Other	Other	Other	Other	Keswick	NCP	Other	Other	Other	3300
1975	Other	Other	Keswick	Keswick	Other	Other	Keswick	Other	NCP	Other	Other	Other	3300
1976	Other	Other	Keswick	Keswick	Other	Keswick	NCP	NCP	Other	Other	Keswick	Keswick	2382
1977	Other	Other	Keswick	Keswick	Other	NCP	Other	NCP	Other	Other	Other	Keswick	715
1978	Other	Keswick	Keswick	Keswick	Other	Other	Other	Other	NCP	NCP	NCP	Keswick	3206
1979	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Keswick	2617
1980	Keswick	Keswick	Keswick	Other	Other	Keswick	Keswick	Keswick	NCP	NCP	NCP	Keswick	2974
1981	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Other	Keswick	2047
1982	Keswick	Keswick	Other	Other	Other	Other	Other	Keswick	Keswick	Keswick	Other	Keswick	3217
1983	Keswick	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	3300
1984	Other	Other	Other	Other	Keswick	Keswick	Keswick	NCP	NCP	NCP	Other	Keswick	3218
1985	Keswick	Other	Other	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Other	Other	2014
1986	NCP	Keswick	Keswick	Keswick	Other	Other	Keswick	NCP	NCP	NCP	NCP	Keswick	2632
1987	Keswick	NCP	Keswick	Keswick	Keswick	Keswick	NCP	NCP	Other	Other	Other	NCP	1972
1988	NCP	NCP	Keswick	Keswick	Other	Other	NCP	Keswick	Other	Other	Other	NCP	1713
1989	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Other	Other	Other	Keswick	1977
1990	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	Keswick	Other	Other	NCP	Other	1690
1991	Other	Keswick	Keswick	Other	Other	Keswick	Keswick	NCP	NCP	NCP	NCP	NCP	980
1992	NCP	Keswick	Keswick	Keswick	Keswick	Keswick	Keswick	NCP	Other	Other	NCP	Other	871
1993	Other	Other	Keswick	Keswick	Keswick	Keswick	Keswick	Other	Other	Other	Other	Keswick	3178
1994	Keswick	Keswick	Keswick	Keswick	Keswick	Other	NCP	NCP	NCP	Other	Other	Keswick	1821

Table V.5.1 shows the factors controlling Shasta releases. In the 1928 to1934 dry period, there are 40 months when Keswick (AFRP or temperature flows), 37 months when NCP (Navigational Control Point) controls, and 7 months when Other (Delta requirements, flood control release, Delta exports or Sacramento River diversions) controls.

Figure V.5.2
Sacramento River Flow Below Keswick Dam

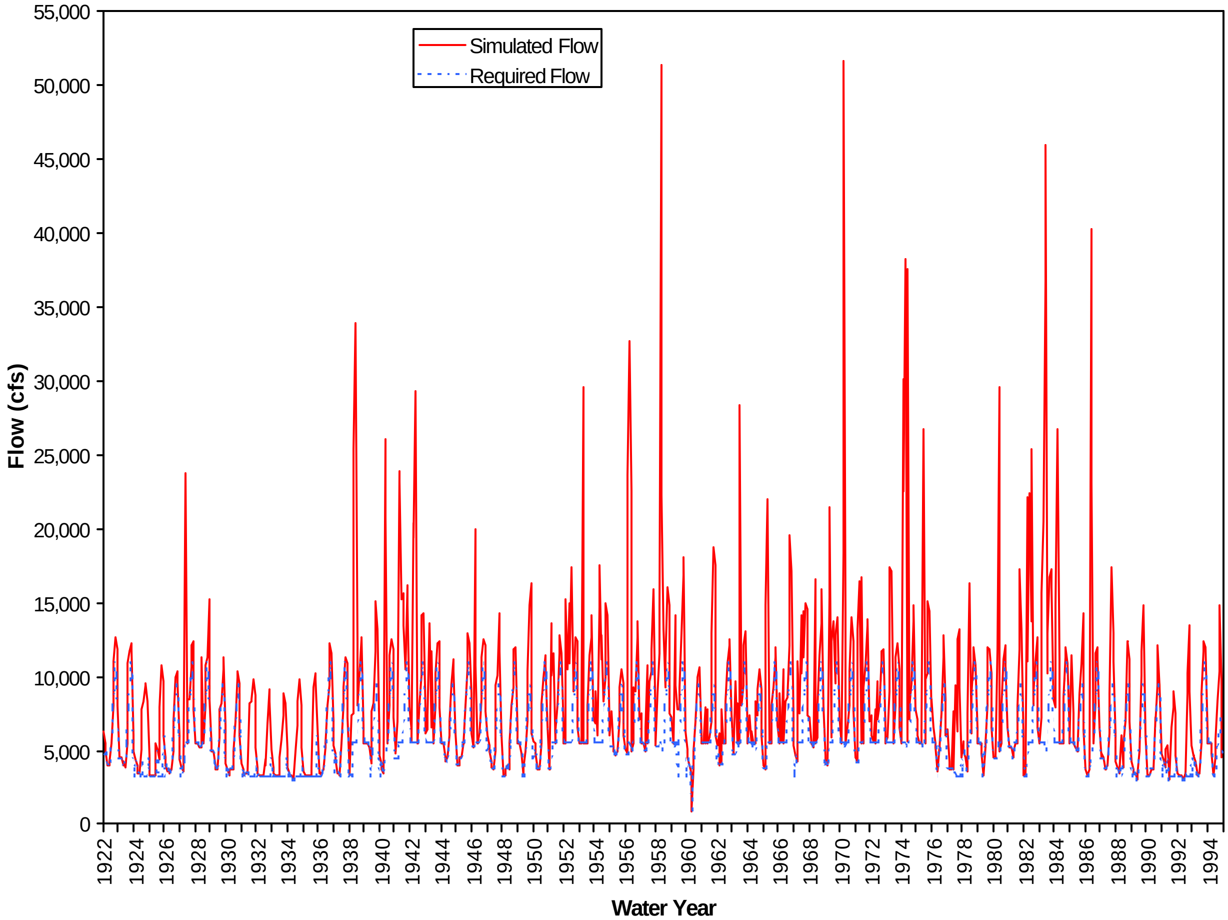


Figure V.5.2 shows the simulated and minimum instream required flows in the Sacramento River below Keswick Dam. The minimum required flows (AFRP and temperature control flows) tend to control the releases from Keswick Dam in the dry years.

V.6. American River

Figure V.6.1
Folsom Lake Storage

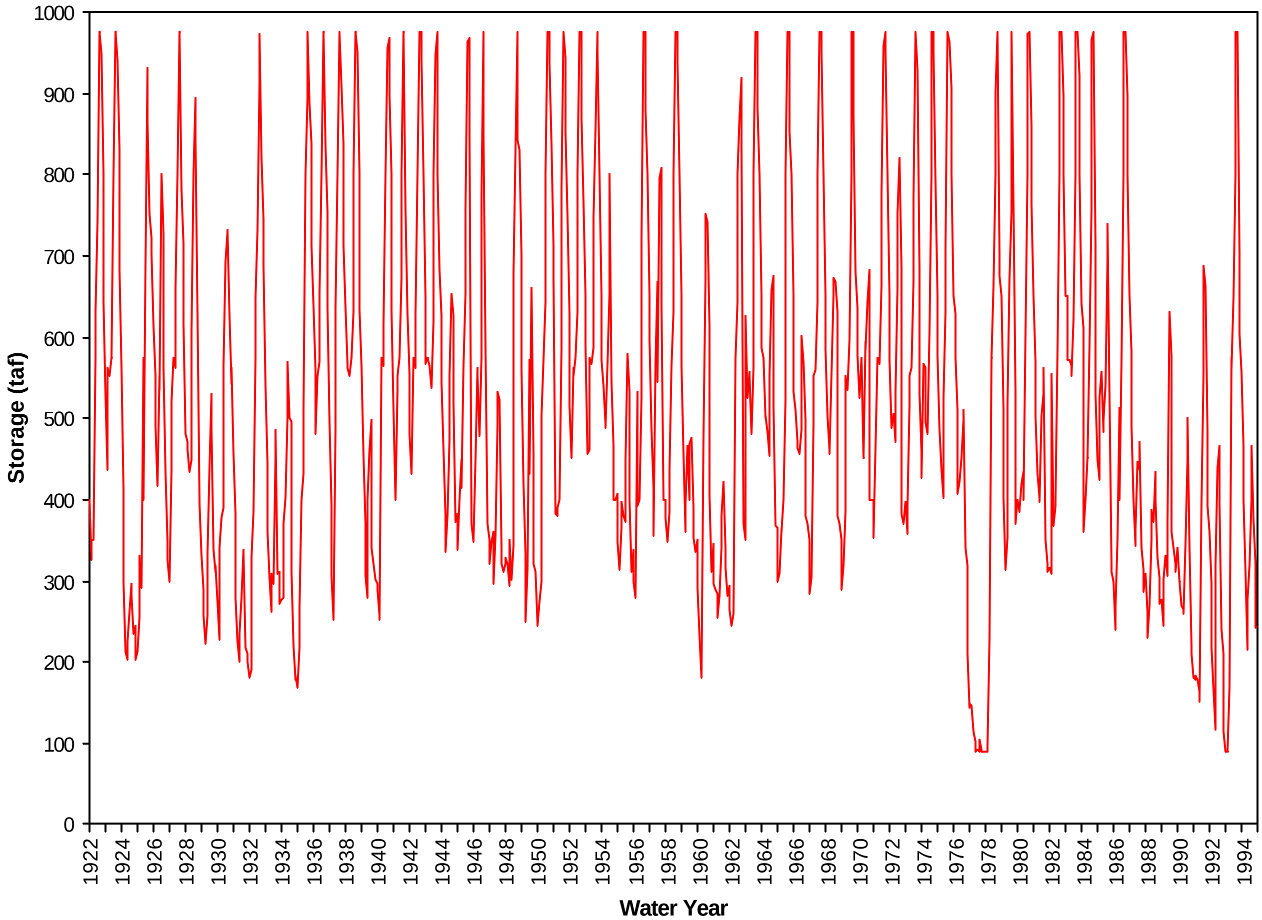


Figure V.6.1 shows Folsom Lake storage. In most months in dry years, Folsom Lake release is controlled by the AFRP flows at Nimbus.

Table V.6.1
Folsom Lake Release Control

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Carryover Storage
1922	Other	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	Nimbus	Other	Other	642
1923	Other	Other	Other	Other	Other	Nimbus	Other	Other	Other	Other	Other	Other	683
1924	Other	Other	Nimbus	Nimbus	Nimbus	Nimbus	H Street	H Street	Other	Other	H Street	Other	204
1925	Other	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Nimbus	Other	Other	Nimbus	Nimbus	703
1926	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Nimbus	Other	Other	Other	Nimbus	325
1927	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Other	Nimbus	Other	615
1928	Other	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Nimbus	394
1929	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	H Street	Nimbus	Other	Other	Other	Nimbus	319
1930	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	563
1931	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	H Street	Nimbus	Nimbus	Other	Other	Other	200
1932	Other	Nimbus	Nimbus	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	688
1933	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	H Street	Other	Other	Other	Other	272
1934	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Other	183
1935	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	713
1936	Other	Other	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	635
1937	Other	Other	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	713
1938	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	634
1939	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	H Street	Other	295
1940	Nimbus	Other	Nimbus	Other	Other	Other	Other	Nimbus	Nimbus	Nimbus	Other	Other	633
1941	Other	Other	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	564
1942	Nimbus	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	Other	Other	Other	648
1943	Nimbus	Other	Other	Other	Other	Other	Other	Nimbus	Other	Other	Other	Other	626
1944	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	383
1945	Nimbus	Nimbus	Nimbus	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	349
1946	Other	Nimbus	Other	Other	Other	Nimbus	Nimbus	Other	Other	Other	Other	Other	350
1947	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	321
1948	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	701
1949	Other	Other	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	247
1950	Other	H Street	H Street	Nimbus	Other	Nimbus	Other	Other	Other	Other	Other	Other	713
1951	Nimbus	Other	Other	Other	Other	Other	Nimbus	Other	Nimbus	Nimbus	Other	Other	628
1952	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	650
1953	Nimbus	Other	Nimbus	Other	Other	Other	Nimbus	Nimbus	Other	Other	Other	Other	650
1954	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Nimbus	407
1955	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	337
1956	Nimbus	Nimbus	Other	Other	Other	Nimbus	Nimbus	Other	Other	Other	Other	Other	650
1957	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	Other	Other	400
1958	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	650
1959	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Nimbus	Nimbus	Other	Nimbus	H Street	Other	350
1960	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	Other	H Street	345
1961	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Nimbus	Other	H Street	H Street	H Street	295
1962	Nimbus	Nimbus	Nimbus	Nimbus	Other	Nimbus	Other	Nimbus	Nimbus	Other	Other	Other	350
1963	Nimbus	Other	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	650
1964	Nimbus	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	365
1965	Other	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	Other	Other	Other	650
1966	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	350
1967	Other	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	650
1968	Nimbus	Other	Nimbus	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	Other	350
1969	Other	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	Other	Other	Other	Nimbus	636
1970	Nimbus	Nimbus	Other	Other	Other	Other	Other	Nimbus	Other	Other	Other	Other	400
1971	Nimbus	Nimbus	Other	Other	Other	Other	Nimbus	Nimbus	Other	Other	Other	Other	650
1972	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Nimbus	Nimbus	Other	Other	Other	Nimbus	398
1973	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	Other	Other	468
1974	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	650
1975	Nimbus	Other	Nimbus	Nimbus	Nimbus	Other	Nimbus	Other	Other	Other	Other	Other	650
1976	Nimbus	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Nimbus	Other	Other	144
1977	H Street	Nimbus	H Street	Nimbus	Nimbus	Nimbus	H Street	H Street	H Street	H Street	H Street	H Street	90
1978	Nimbus	Nimbus	H Street	Other	Other	Other	Other	Nimbus	Other	Other	Nimbus	Other	650
1979	Other	Other	Nimbus	Nimbus	Nimbus	Other	Nimbus	Other	Other	Other	Other	Nimbus	400
1980	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Nimbus	Other	Other	Other	Other	650
1981	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	315
1982	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	660
1983	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	Other	640
1984	Other	Other	Other	Other	Other	Other	Nimbus	Nimbus	Other	Other	Other	Other	448
1985	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	300
1986	Other	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	Other	Other	Other	Other	650
1987	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	H Street	Other	H Street	H Street	Nimbus	309
1988	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	H Street	H Street	H Street	276
1989	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	Other	Other	Other	340
1990	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	180
1991	H Street	Nimbus	H Street	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Other	360
1992	Other	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	H Street	Other	Other	90
1993	Nimbus	H Street	H Street	Other	Other	Other	Other	Other	Other	Other	Other	Other	565
1994	Other	Other	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Nimbus	Other	Other	Other	Nimbus	244

Table V.6.1 shows the factors controlling Folsom Lake release. In the 1928 to1934 dry period, there are 47 months when Nimbus minimum required flow controls, 3 months when H Street minimum required flow controls, 34 months when other (American River diversions, Delta required flows, Delta exports, or flood control releases) controls.

Figure V.6.2
American River Flow at Nimbus Dam

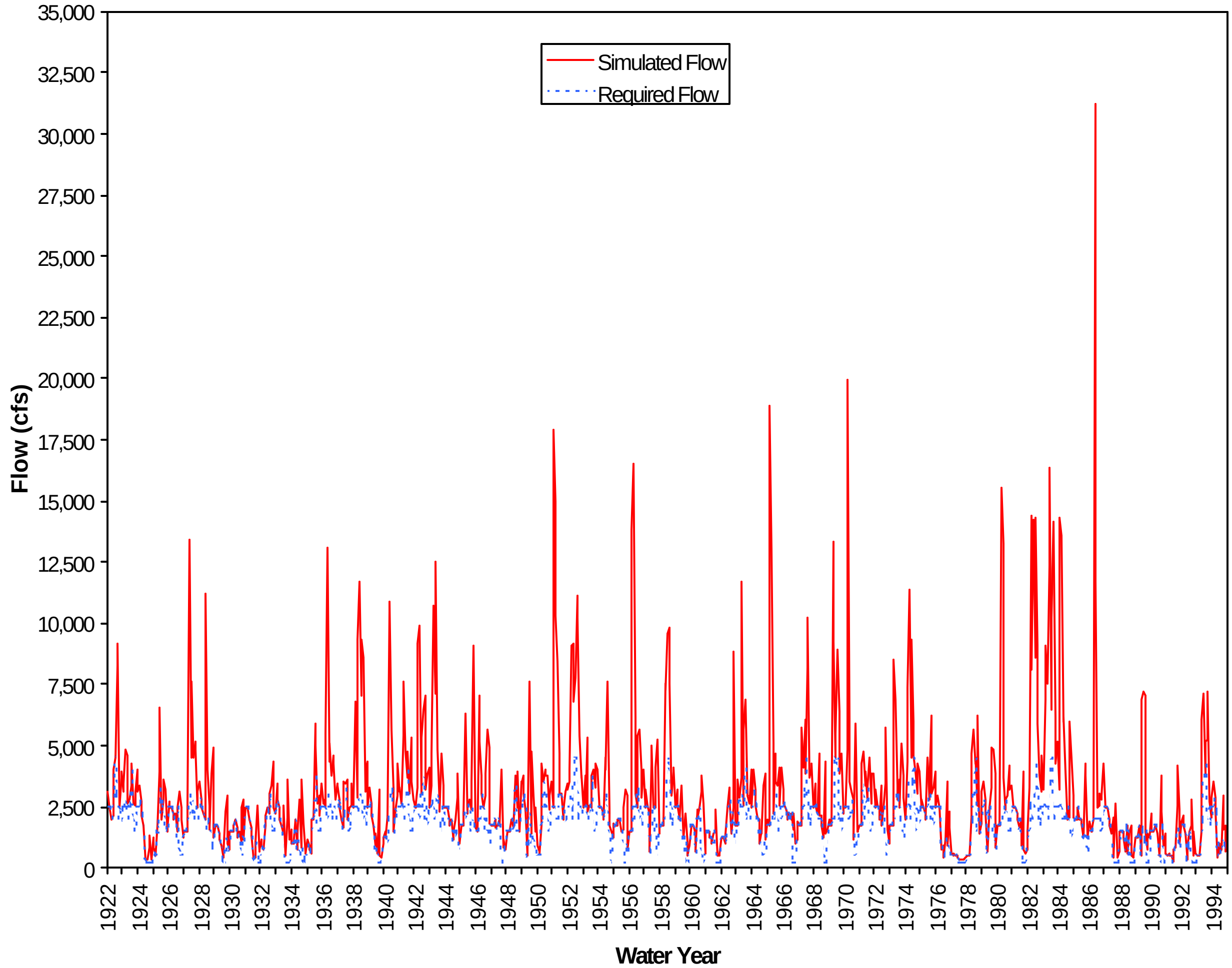


Figure V.6.2 shows the simulated and minimum instream required flows in the American River below Nimbus Dam. The minimum instream flows at Nimbus tend to control Folsom reservoir operations in some months of most years.

Figure V.6.3
American River Flow at H St

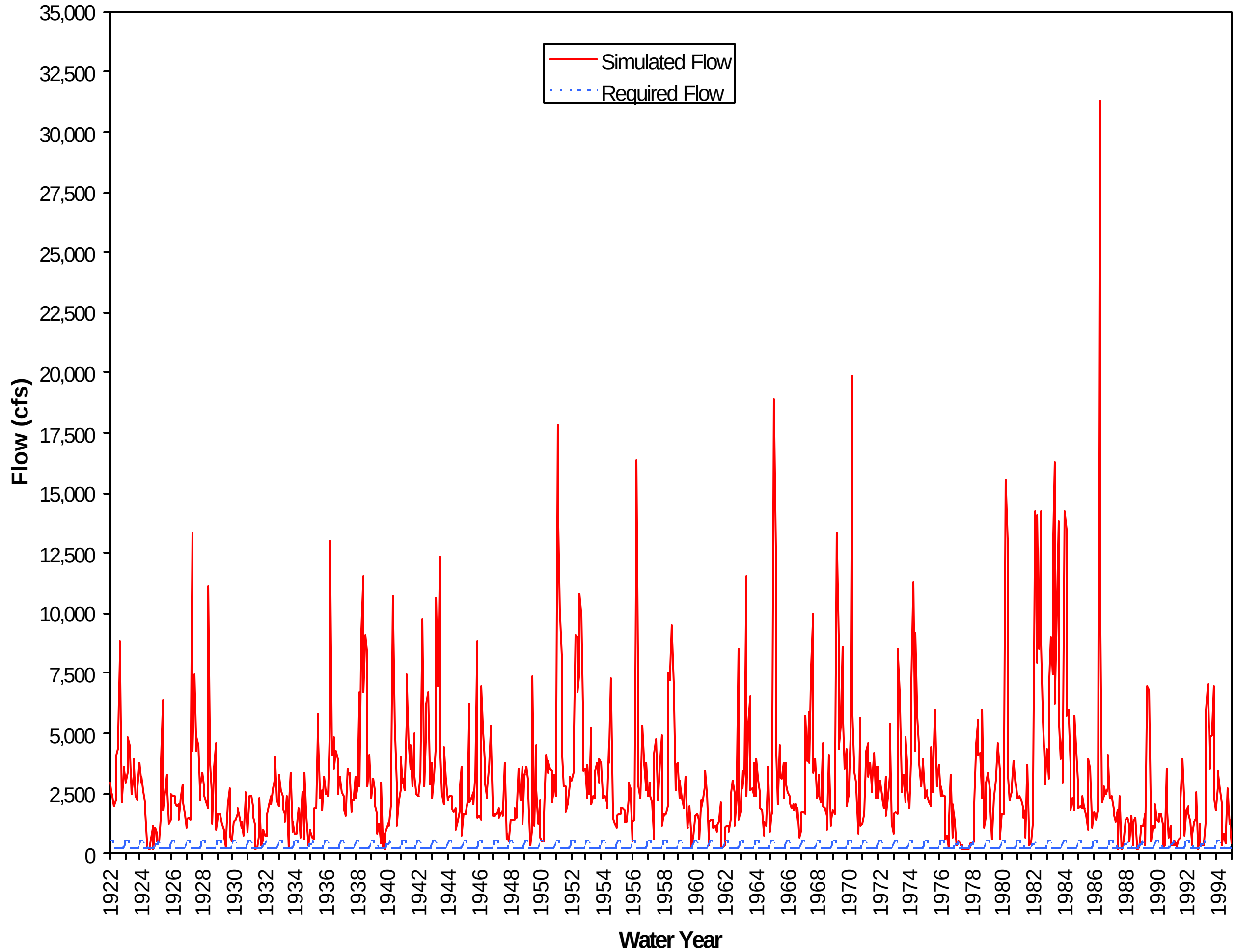


Figure V.6.3 shows the simulated and minimum instream required flows in the American River at H Street. The minimum instream flows at Nimbus tend to control Folsom reservoir operations in some months of most years.

V.7. Feather River

Figure V.7.1
Lake Oroville Storage

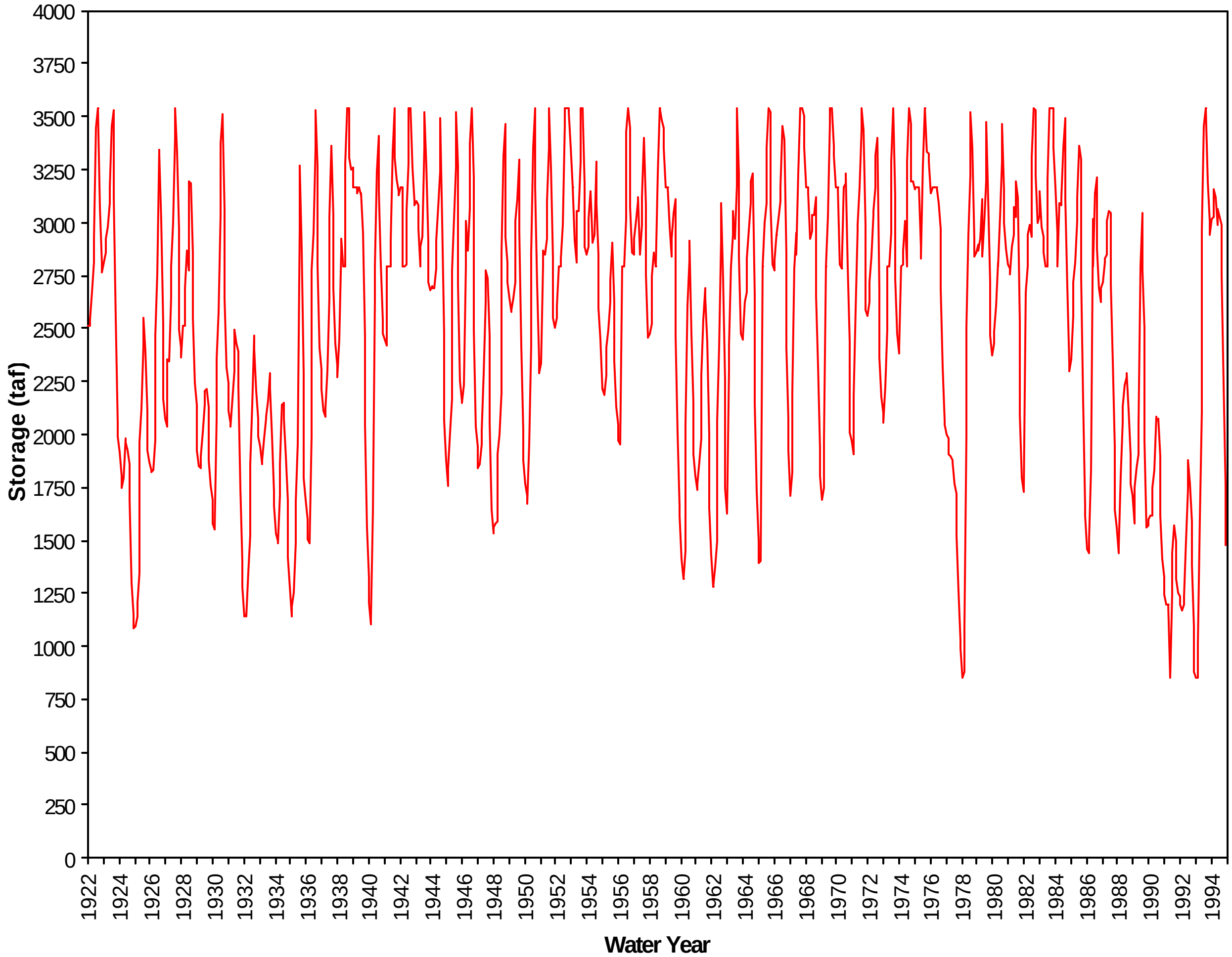


Figure V.7.1 shows Lake Oroville storage. The lowest storage value is 850 taf.

Figure V.7.2

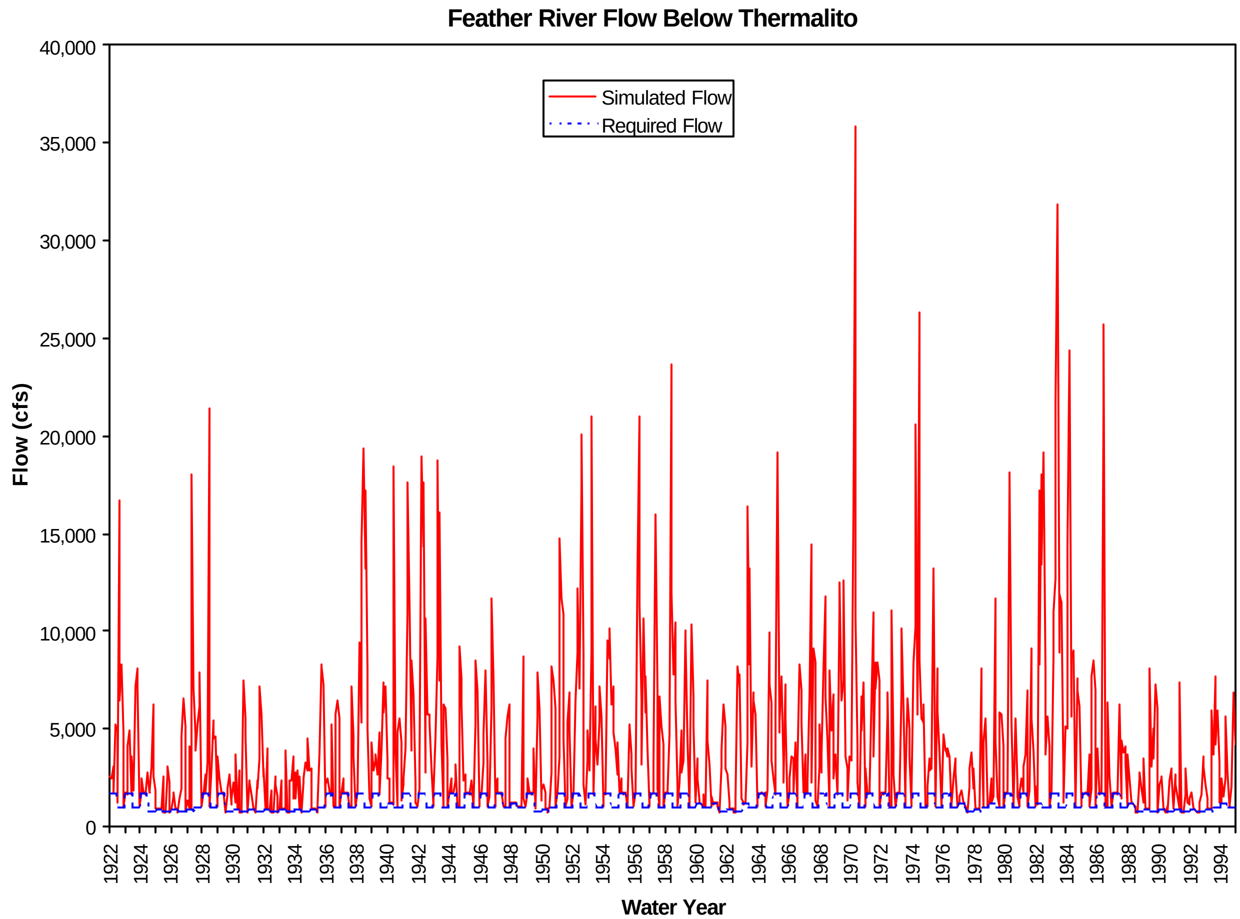


Figure V.7.2 shows simulated and minimum instream required flows in the Feather River below Thermalito Diversion Dam. The simulated flows are almost always higher than the minimum required flows. The river's minimum instream flow does not control Oroville reservoir operations in most years.

V.8. Stanislaus/San Joaquin Rivers

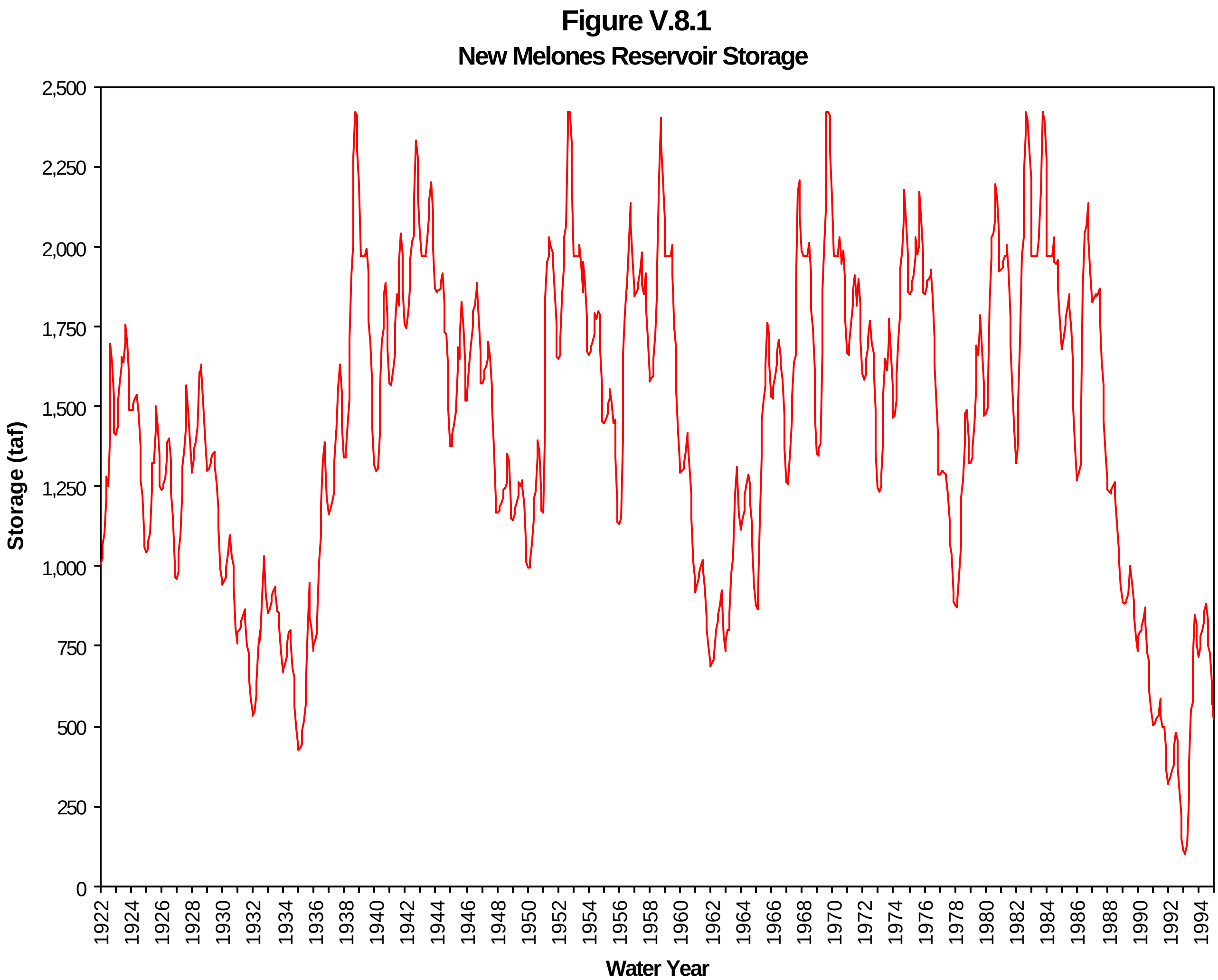


Figure V.8.1 shows New Melones Reservoir storage.

Figure V.8.2
Stanislaus River Flow Below Goodwin Dam

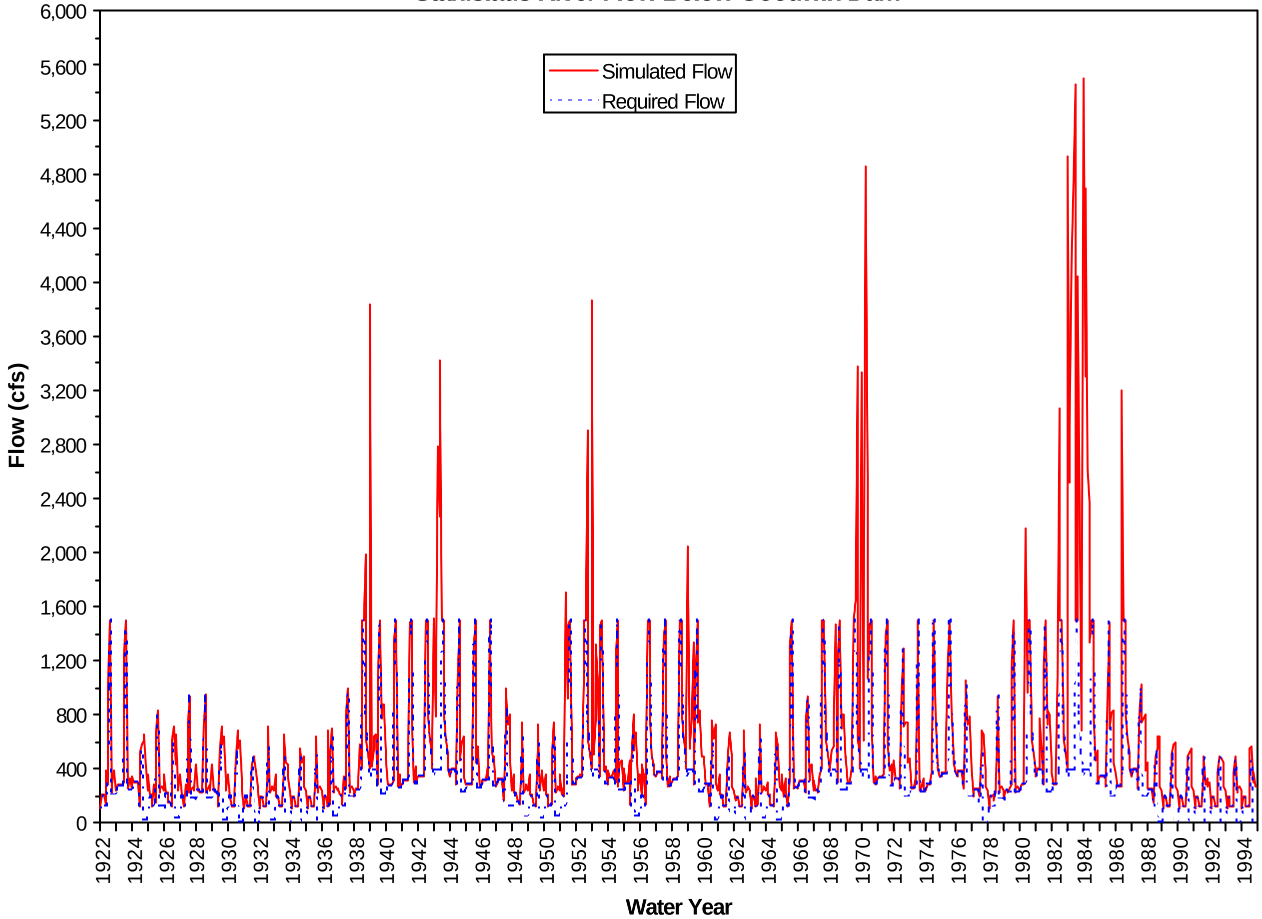


Figure V.8.2 shows the simulated and minimum instream required flows in the Stanislaus River at Goodwin. The minimum instream flows tend to control New Melones releases at Goodwin Dam in some months of most years.

Figure V.8.3
San Joaquin River simulated flow at Vernalis

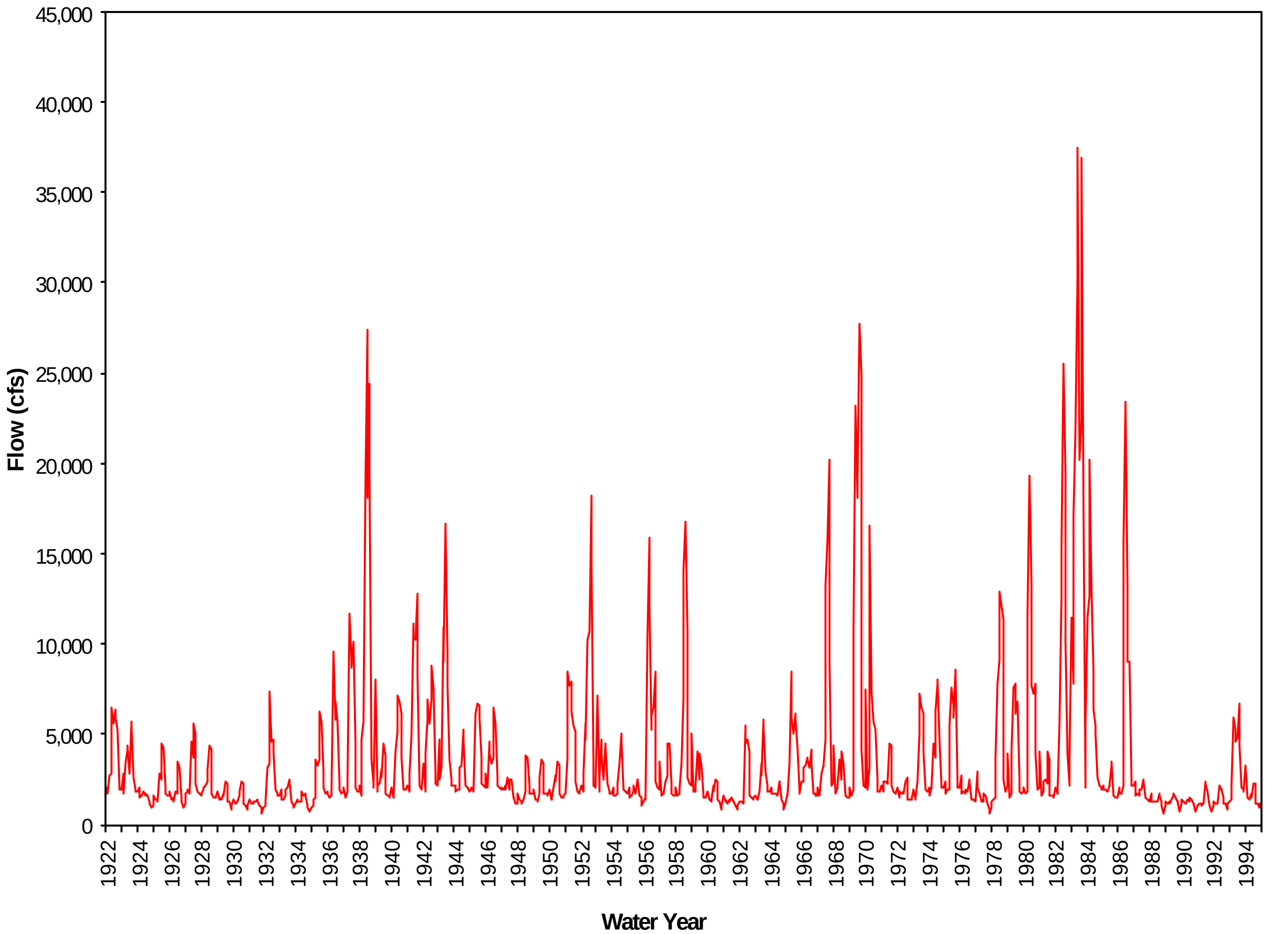


Figure V.8.3 shows the simulated San Joaquin River flow at Vernalis.

V.9. Delta

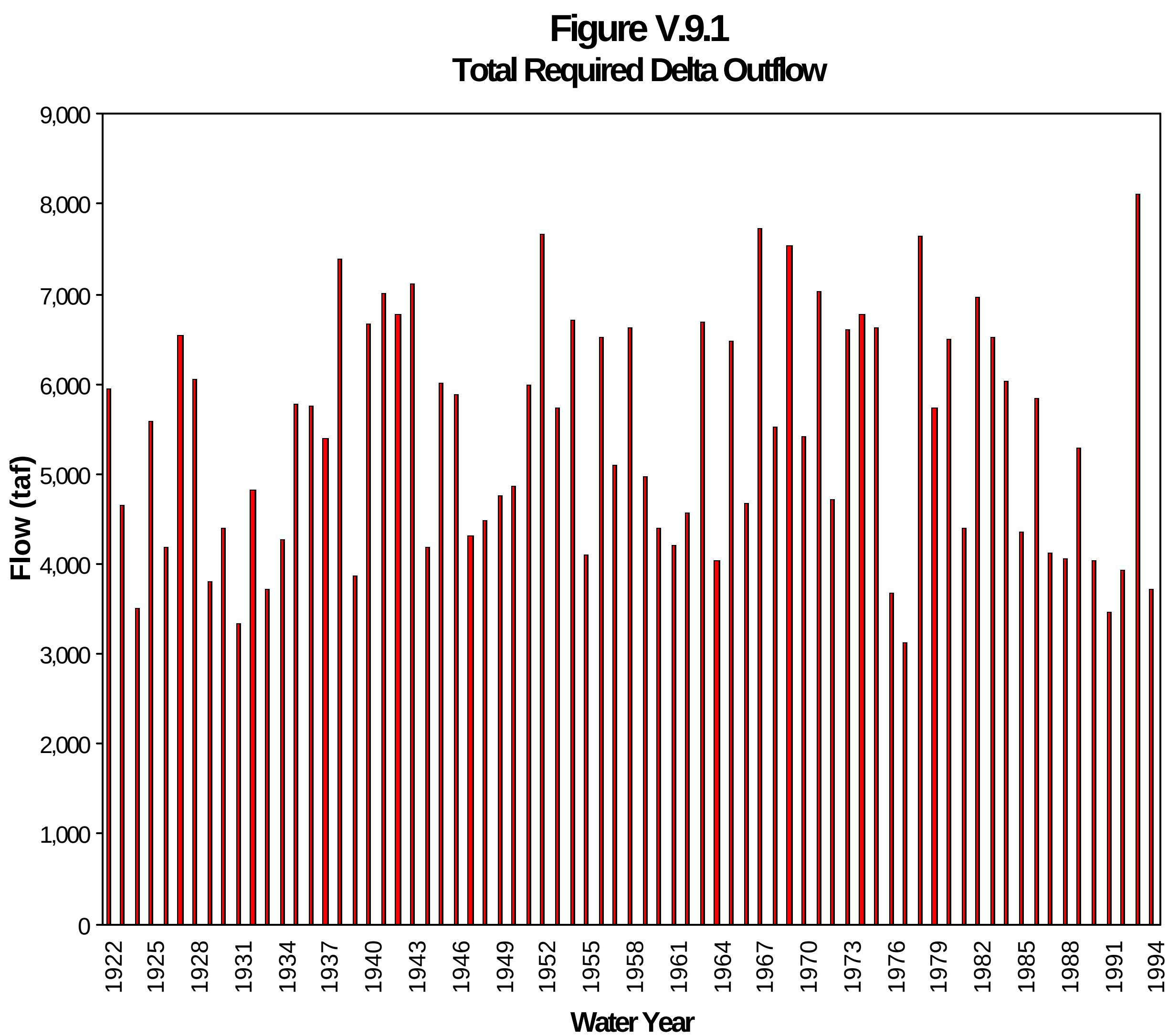


Figure V.9.1 shows the total annual required Delta outflow. The total required outflow is the flow needed to meet x2 and minimum outflow requirements. The average annual total required Delta outflow is 5,417 taf.

Figure V.9.2
Total Delta Outflow

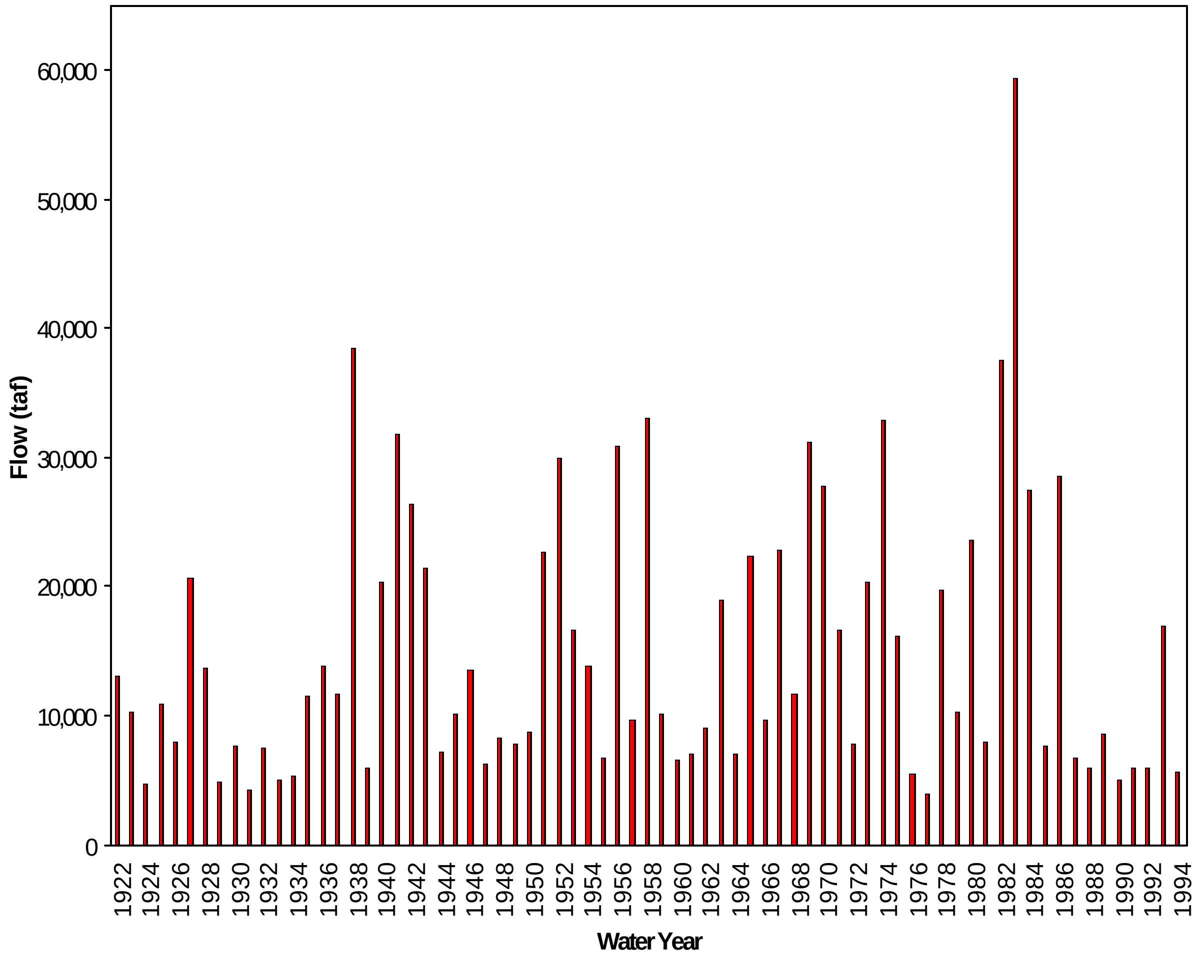


Figure V.9.2 shows annual total Delta outflow. The average annual total Delta outflow is 14,990 taf.

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Figure V.9.3
Minimum Required Flow at Sacramento River at Freeport for ANN Requirements

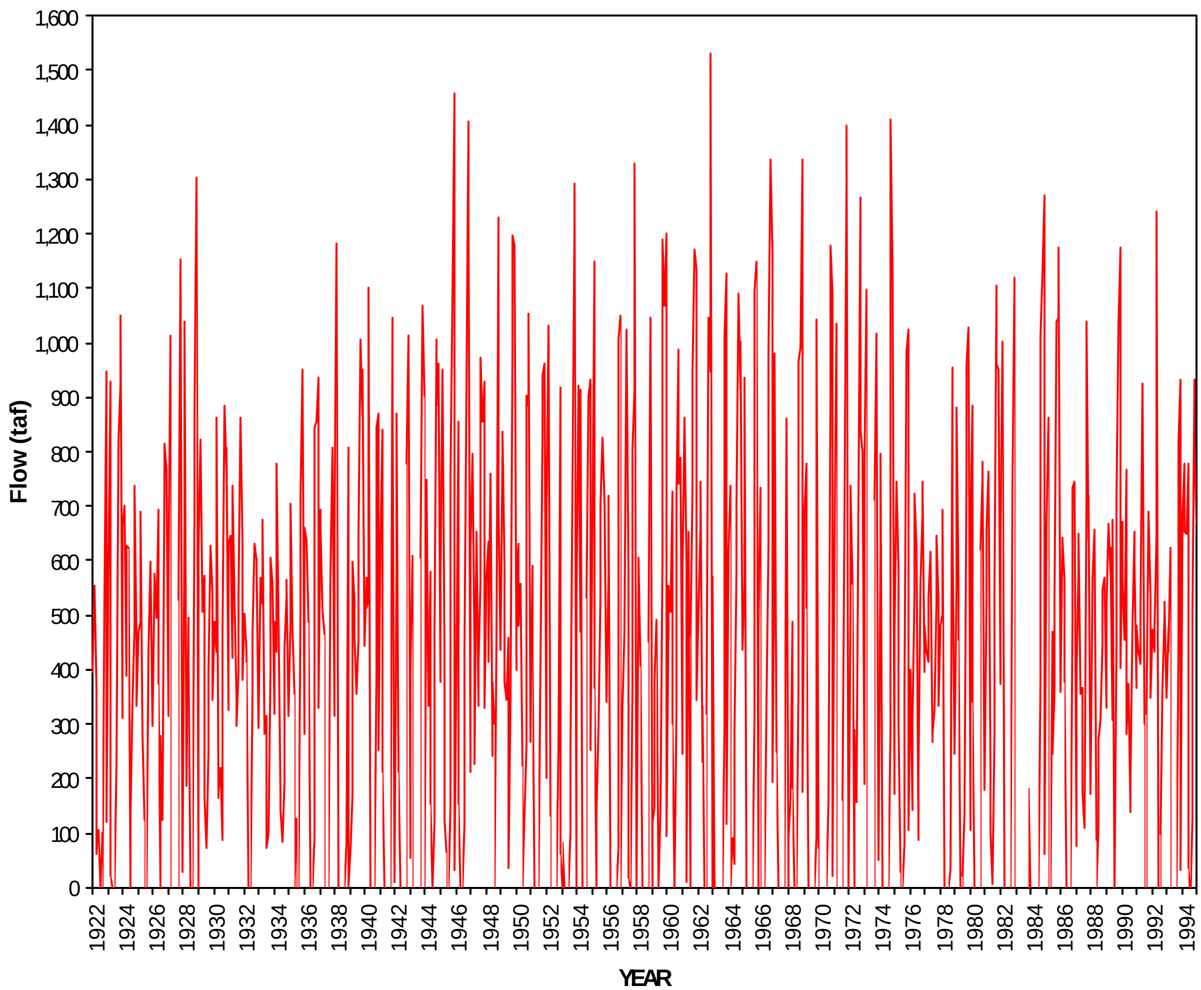

Figure V.9.3 shows the total required flow at Sacramento River at Freeport for Artificial Neural Network salinity requirements.

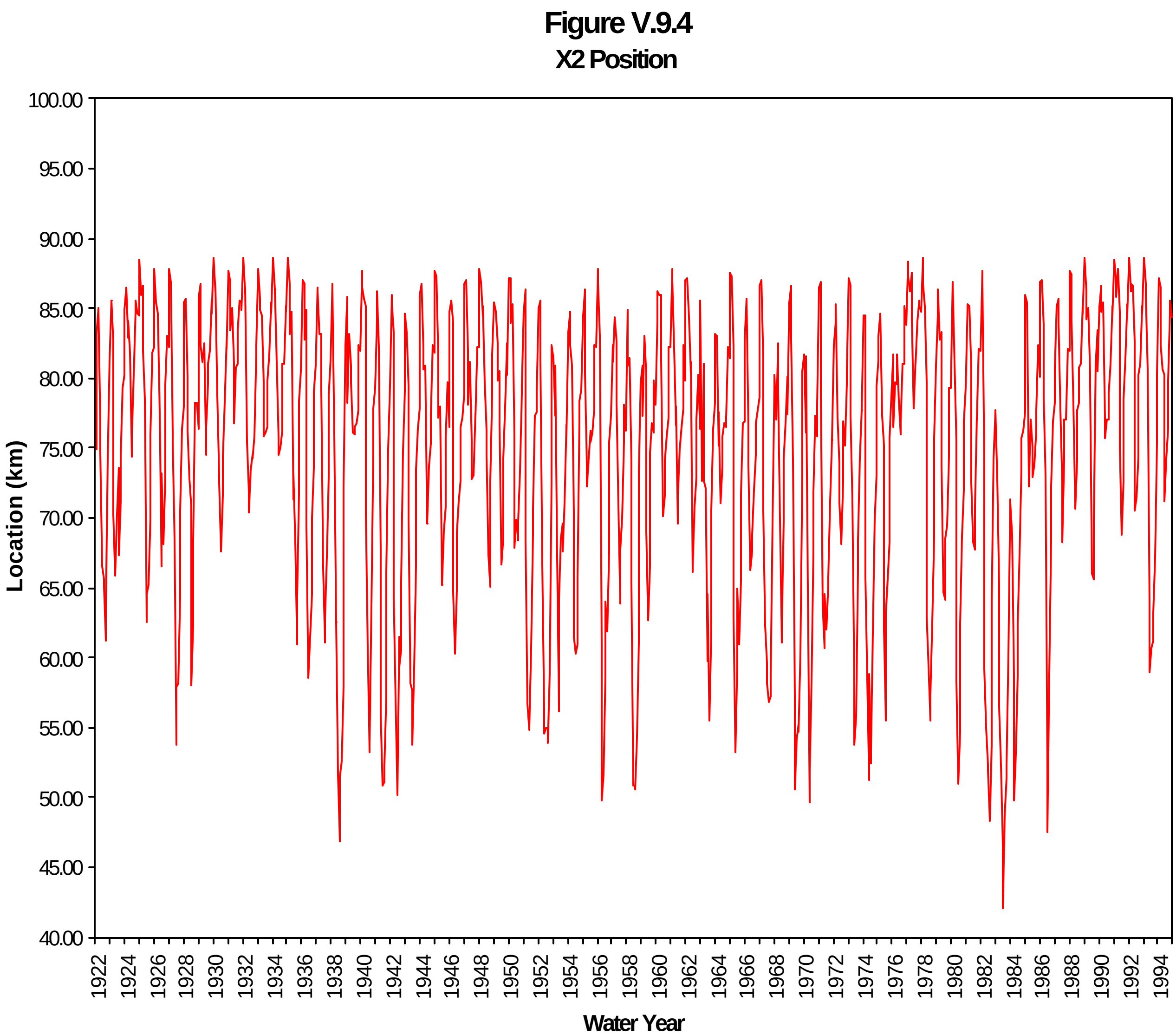

Figure V.9.4 shows the monthly resulting X2 position. The X2 position ranges from 42 km to 88 km.

Figure V.9.5
Average Monthly QWEST Flows

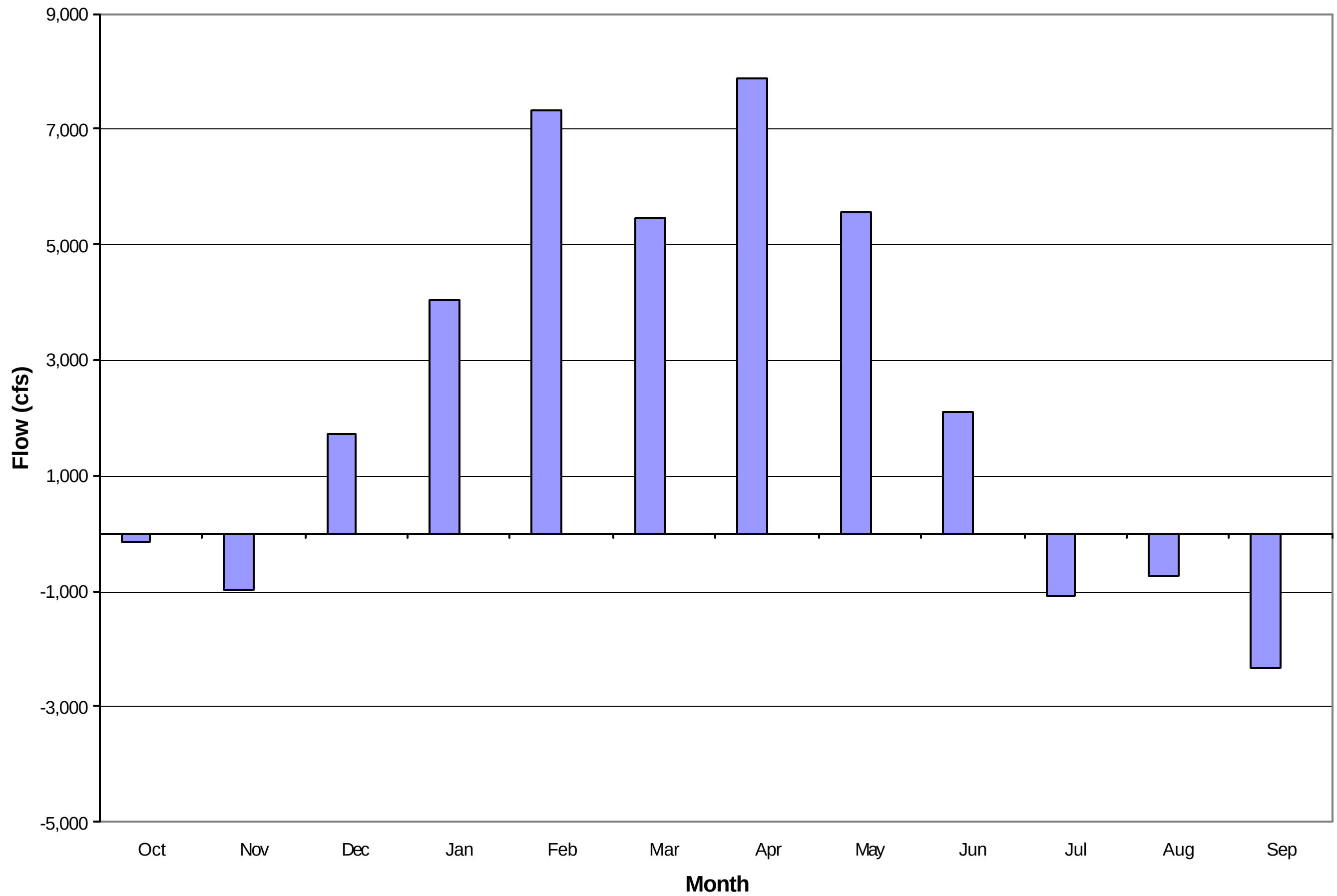

Figure V.9.5 shows the average monthly QWEST flows. The average QWEST flows are negative in October, November, July, August, and September.

V.10. South-of-Delta

Figure V.10.1
SWP San Luis Reservoir Storage

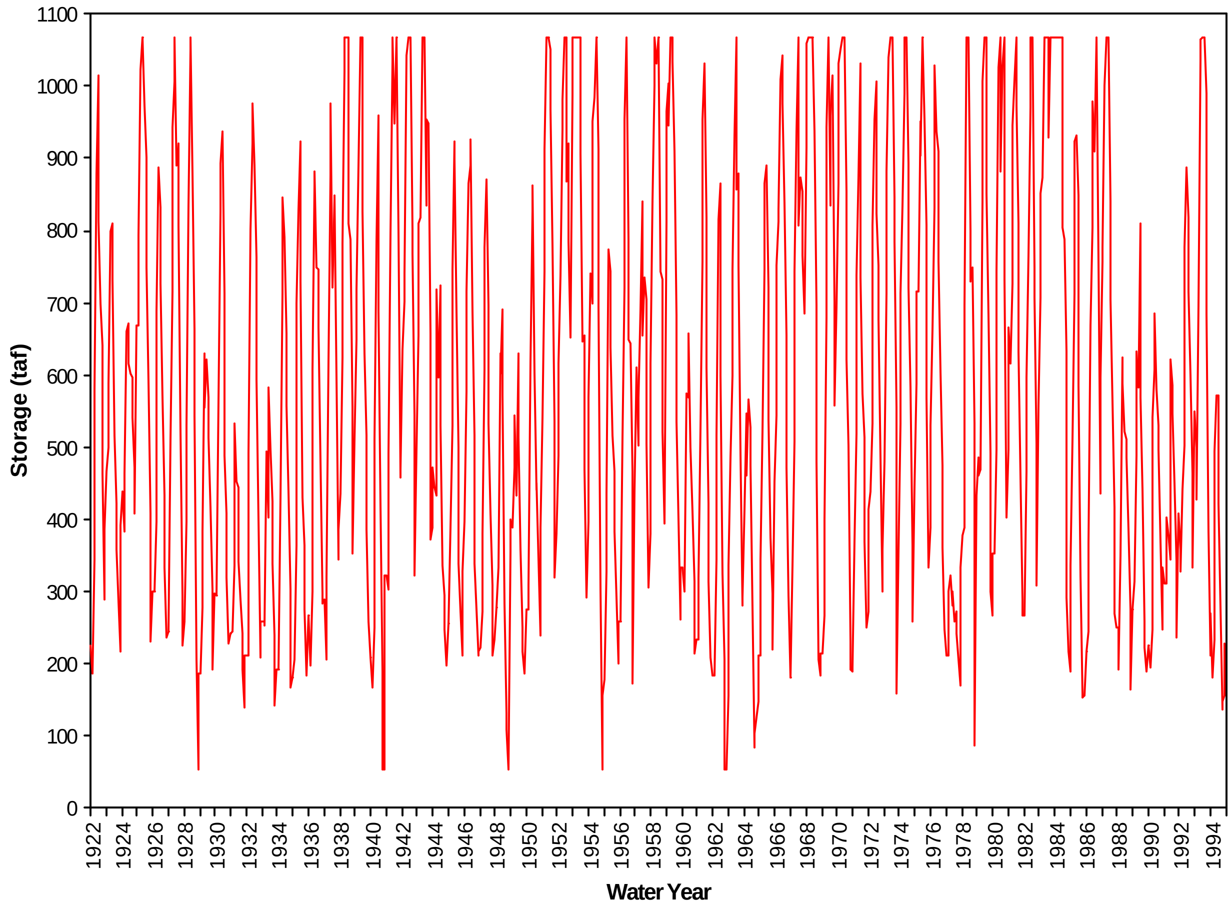

Figure V.10.1 shows SWP San Luis reservoir storage. The low points shown do not include EWA's storage debt owed to the SWP. The September end-of-month storage in SWP San Luis includes EWA debt payback.

Figure V.10.2
CVP San Luis Reservoir Storage

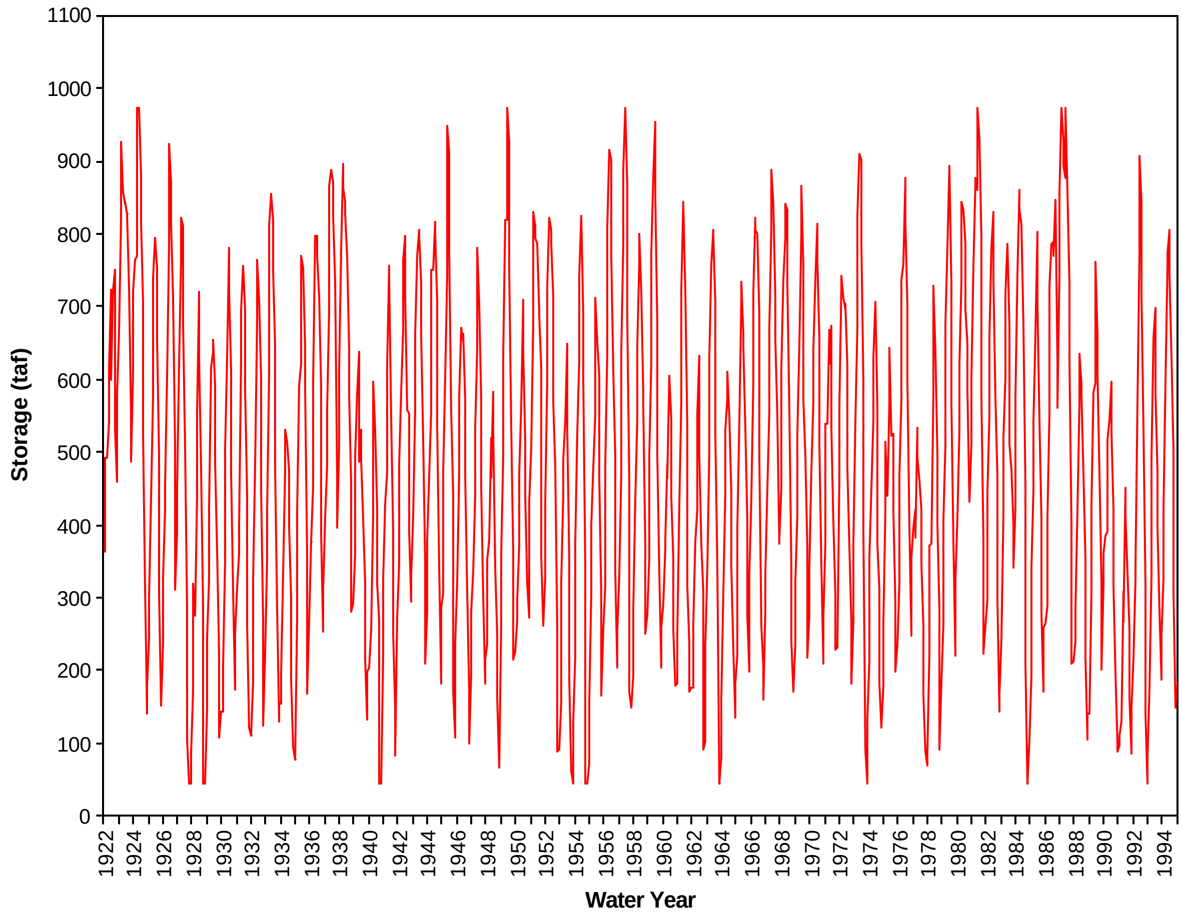

Figure V.10.2 shows CVP San Luis reservoir storage. The low points shown do not include EWA's storage debt owed to the projects. The September end-of-month storage in CVP San Luis Reservoir includes EWA debt payback .

V.11. CVPIA (b)(2) Accounting Metrics Computations

This section shows the computations of the storage, release and export metrics developed by the Department of the Interior for accounting the (b)(2) cost. The computations included in this report are for water years 1922 through 1926 for the sample study. The computations for the entire 73-year study period are available but are too massive to include in this report.

Table V.11.1 shows the storage, releases, and exports from the D1485 study. The D1485 study is the baseline from which the CVP WQCP cost in the WQCP study is measured. Trinity, Shasta, Folsom, and New Melones Lake storages are shown in columns B through E, and the total storage of all the reservoirs is shown in column F. The releases below Goodwin Dam, Whiskeytown Lake, Keswick Reservoir, and Lake Natoma (Nimbus) are shown in columns G – J, and the total of all the releases is shown in column L. The CVP exports at Tracy Pumping Plant and CVP wheeling are shown in columns M and N, and the total CVP exports are shown in column O.

Table V.11.2 shows the storage, releases, and exports from the WQCP study. The WQCP study is used to compute the CVP WQCP cost as measured from the D1485 study. It is also the baseline from which the (b)(2) cost is measured against in the (b)(2) study. Trinity, Shasta, Folsom, and New Melones Lake storages are shown in columns B through E, and the total storage of all the reservoirs is shown in column F. The releases below Goodwin Dam, Whiskeytown Lake, Keswick Reservoir, and Lake Natoma (Nimbus) are shown in columns G – J, and the total of all the releases is shown in column L. The CVP exports at Tracy Pumping Plant and CVP wheeling are shown in columns M and N, and the total CVP exports are shown in column O.

Table V.11.3 shows the storage, releases, and exports from the (b)(2) study. The (b)(2) study is used to compute the cost of (b)(2) actions as measured against the WQCP study. Trinity, Shasta, Folsom, and New Melones Lake storages are shown in columns B through E, and the total storage of all the reservoirs is shown in column F. The releases below Goodwin Dam, Whiskeytown Lake, Keswick Reservoir, and Lake Natoma (Nimbus) are shown in columns G – J, and the total of all the releases is shown in column L. The CVP exports at Tracy Pumping Plant and CVP wheeling are shown in columns M and N, and the total CVP exports are shown in column O.

Table V.11.1

D1485 Results

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Storage (TAF)					Releases (TAF)						Exports (TAF)		
Date	Trinity	Shasta	Folsom	New Melones	**Total**	Goodwin	Whiskeytown	Keswick	Natoma		**Total**	Tracy	CVP Banks	**Total**
Oct-21	1,850	2,740	458	1,004	**6,053**	7	3	379	132		**521**	270	40	**310**
Nov-21	1,837	2,735	424	1,025	**6,021**	12	6	255	108		**381**	240	40	**279**
Dec-21	1,839	2,876	522	1,063	**6,300**	12	6	200	80		**298**	260	0	**260**
Jan-22	1,836	2,989	553	1,103	**6,480**	8	3	200	92		**303**	260	0	**260**
Feb-22	1,850	3,366	575	1,211	**7,002**	22	3	180	322		**527**	236	0	**236**
Mar-22	1,890	3,766	631	1,287	**7,574**	8	3	200	247		**458**	265	0	**265**
Apr-22	1,979	4,203	800	1,297	**8,280**	15	3	327	209		**554**	221	0	**221**
May-22	1,935	4,443	975	1,529	**8,881**	31	3	492	565		**1,090**	184	0	**184**
Jun-22	1,989	4,096	975	1,816	**8,876**	13	3	654	544		**1,215**	178	0	**178**
Jul-22	1,877	3,611	816	1,760	**8,065**	24	3	776	287		**1,090**	283	56	**339**
Aug-22	1,785	3,127	739	1,659	**7,309**	29	3	725	154		**911**	281	33	**314**
Sep-22	1,725	2,860	650	1,544	**6,779**	14	3	479	162		**659**	267	0	**267**
Oct-22	1,598	2,684	575	1,417	**6,273**	7	3	224	148		**381**	265	40	**305**
Nov-22	1,584	2,762	510	1,443	**6,299**	12	6	193	179		**390**	207	40	**247**
Dec-22	1,586	2,906	561	1,519	**6,573**	13	6	200	369		**588**	259	0	**259**
Jan-23	1,604	3,124	553	1,595	**6,875**	8	3	200	284		**494**	85	0	**85**
Feb-23	1,627	3,260	575	1,656	**7,118**	7	3	180	144		**335**	107	0	**107**
Mar-23	1,675	3,402	559	1,697	**7,333**	8	3	200	184		**395**	181	0	**181**
Apr-23	1,793	3,650	800	1,732	**7,976**	15	3	327	184		**529**	71	0	**71**
May-23	1,675	3,410	975	1,876	**7,936**	31	3	673	262		**969**	184	0	**184**
Jun-23	1,532	3,100	975	1,945	**7,553**	13	3	703	157		**875**	178	0	**178**
Jul-23	1,363	2,676	942	1,889	**6,869**	17	3	763	154		**937**	80	0	**80**
Aug-23	1,274	2,180	838	1,786	**6,078**	23	3	725	184		**935**	117	21	**138**
Sep-23	1,235	1,990	713	1,676	**5,614**	14	3	387	214		**618**	259	0	**259**
Oct-23	1,000	1,855	608	1,494	**4,957**	10	3	306	148		**467**	260	40	**300**
Nov-23	981	1,878	474	1,504	**4,837**	12	6	197	184		**399**	81	33	**113**
Dec-23	965	1,900	448	1,526	**4,839**	12	6	200	80		**298**	125	0	**125**
Jan-24	951	1,937	422	1,553	**4,864**	8	3	200	74		**284**	214	0	**214**
Feb-24	1,000	2,097	449	1,576	**5,122**	7	3	187	63		**260**	54	0	**54**
Mar-24	997	2,112	447	1,575	**5,130**	8	2	226	46		**282**	104	0	**104**
Apr-24	903	1,900	380	1,519	**4,702**	20	2	490	123		**635**	7	0	**7**
May-24	631	1,722	374	1,430	**4,157**	31	2	546	61		**640**	184	0	**184**
Jun-24	500	1,394	320	1,376	**3,590**	37	2	563	89		**691**	12	0	**12**
Jul-24	391	1,036	245	1,285	**2,957**	41	2	588	108		**738**	17	0	**17**
Aug-24	347	692	217	1,161	**2,416**	24	2	512	61		**599**	13	0	**13**
Sep-24	300	550	189	1,128	**2,167**	14	2	319	59		**395**	193	0	**193**
Oct-24	248	550	217	1,055	**2,070**	7	2	184	46		**239**	150	0	**150**
Nov-24	317	690	249	1,069	**2,326**	12	4	178	48		**242**	117	0	**117**
Dec-24	365	800	295	1,092	**2,552**	12	4	184	61		**262**	259	0	**259**
Jan-25	417	935	316	1,116	**2,784**	8	2	184	46		**240**	259	0	**259**
Feb-25	688	2,220	575	1,253	**4,736**	16	2	167	243		**428**	235	0	**235**
Mar-25	823	2,566	616	1,337	**5,342**	8	3	184	184		**380**	232	0	**232**
Apr-25	1,000	3,286	800	1,365	**6,451**	15	3	297	225		**540**	192	0	**192**
May-25	925	3,364	975	1,498	**6,761**	31	3	430	235		**699**	184	0	**184**
Jun-25	770	3,251	685	1,582	**6,289**	13	3	495	436		**948**	178	0	**178**
Jul-25	701	2,775	320	1,535	**5,331**	16	3	677	448		**1,144**	108	128	**237**
Aug-25	665	2,340	327	1,444	**4,777**	18	3	606	61		**689**	106	0	**106**
Sep-25	639	2,176	305	1,342	**4,462**	14	3	357	104		**478**	265	44	**310**
Oct-25	623	2,140	609	1,253	**4,625**	7	3	277	169		**456**	239	0	**239**
Nov-25	617	2,171	574	1,262	**4,625**	12	6	222	124		**364**	81	0	**81**
Dec-25	636	2,222	574	1,275	**4,708**	12	6	200	91		**309**	154	0	**154**
Jan-26	637	2,271	546	1,291	**4,745**	8	3	200	92		**303**	259	0	**259**
Feb-26	781	2,997	575	1,366	**5,720**	8	3	180	218		**408**	234	0	**234**
Mar-26	884	3,205	605	1,408	**6,102**	8	3	200	92		**303**	262	0	**262**
Apr-26	1,000	3,557	800	1,435	**6,792**	15	3	297	157		**472**	126	0	**126**
May-26	850	3,441	742	1,386	**6,418**	31	3	431	138		**603**	151	0	**151**
Jun-26	707	3,132	674	1,335	**5,848**	28	3	595	89		**716**	38	0	**38**
Jul-26	652	2,673	570	1,214	**5,109**	43	3	641	125		**813**	19	38	**57**
Aug-26	609	2,246	317	1,059	**4,231**	36	3	588	289		**917**	14	108	**123**
Sep-26	570	2,056	310	1,000	**3,936**	14	3	364	59		**441**	256	0	**256**

Table V.11.2

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
WQCP Results														
	Storage (TAF)					Releases (TAF)						Exports (TAF)		
Date	Trinity	Shasta	Folsom	lew Melone	**Total**	Goodwin	Whiskeytown	Keswick	Natoma		**Total**	Tracy	CVP wheeling	**Total**
Oct-21	1,850	2,740	458	1,007	**6,056**	7	3	379	132		**521**	270	40	**310**
Nov-21	1,837	2,735	424	1,027	**6,023**	13	6	255	108		**382**	240	40	**280**
Dec-21	1,839	2,876	522	1,065	**6,301**	13	6	200	80		**299**	260	0	**260**
Jan-22	1,836	2,989	553	1,104	**6,481**	8	3	200	92		**303**	260	0	**260**
Feb-22	1,850	3,366	575	1,212	**7,003**	22	3	180	322		**527**	236	0	**236**
Mar-22	1,890	3,766	631	1,280	**7,568**	17	3	200	247		**468**	265	0	**265**
Apr-22	1,979	4,203	800	1,250	**8,232**	60	3	327	209		**599**	220	0	**220**
May-22	1,935	4,443	975	1,415	**8,768**	92	3	492	565		**1,152**	239	0	**239**
Jun-22	1,987	4,098	975	1,694	**8,754**	13	3	654	544		**1,215**	272	0	**272**
Jul-22	1,875	3,614	868	1,630	**7,987**	24	3	776	234		**1,037**	274	0	**274**
Aug-22	1,783	3,129	791	1,520	**7,223**	29	3	725	154		**911**	281	0	**281**
Sep-22	1,723	2,862	622	1,409	**6,616**	14	3	479	243		**739**	267	18	**286**
Oct-22	1,598	2,684	568	1,412	**6,261**	15	3	224	154		**396**	265	40	**305**
Nov-22	1,584	2,762	511	1,432	**6,289**	17	6	193	172		**388**	220	40	**260**
Dec-22	1,586	2,906	561	1,504	**6,558**	17	6	200	370		**593**	259	0	**259**
Jan-23	1,604	3,124	553	1,570	**6,850**	17	3	200	284		**504**	73	0	**73**
Feb-23	1,627	3,260	575	1,622	**7,084**	16	3	180	144		**343**	107	0	**107**
Mar-23	1,675	3,402	559	1,655	**7,291**	19	3	200	184		**406**	179	0	**179**
Apr-23	1,793	3,650	800	1,636	**7,879**	74	3	327	184		**588**	137	0	**137**
May-23	1,675	3,410	975	1,700	**7,761**	92	3	673	262		**1,030**	214	0	**214**
Jun-23	1,532	3,100	975	1,757	**7,365**	18	3	703	157		**880**	183	0	**183**
Jul-23	1,363	2,676	924	1,693	**6,656**	18	3	763	171		**955**	83	18	**100**
Aug-23	1,274	2,180	822	1,583	**5,858**	23	3	725	183		**934**	172	16	**188**
Sep-23	1,235	1,943	713	1,482	**5,373**	15	3	433	198		**649**	260	30	**290**
Oct-23	1,000	1,855	608	1,486	**4,949**	21	3	306	148		**478**	260	40	**300**
Nov-23	981	1,878	494	1,489	**4,842**	18	6	197	165		**386**	81	33	**113**
Dec-23	965	1,900	467	1,505	**4,838**	19	6	200	80		**305**	128	0	**128**
Jan-24	951	1,937	441	1,521	**4,851**	19	3	200	74		**295**	210	0	**210**
Feb-24	1,000	2,097	468	1,534	**5,099**	18	3	187	63		**271**	54	0	**54**
Mar-24	997	2,112	403	1,534	**5,046**	8	2	226	109		**345**	3	0	**3**
Apr-24	903	1,900	415	1,474	**4,692**	31	2	490	45		**567**	86	0	**86**
May-24	631	1,722	408	1,375	**4,137**	36	2	546	61		**645**	85	0	**85**
Jun-24	500	1,394	354	1,269	**3,517**	37	2	563	89		**690**	68	0	**68**
Jul-24	391	1,036	279	1,220	**2,926**	40	2	588	108		**738**	16	0	**16**
Aug-24	347	692	250	1,089	**2,378**	26	2	512	61		**601**	12	0	**12**
Sep-24	300	550	222	1,062	**2,134**	14	2	319	59		**395**	175	0	**175**
Oct-24	248	550	200	1,044	**2,041**	22	2	184	63		**271**	183	0	**183**
Nov-24	317	690	232	1,057	**2,297**	12	4	178	48		**243**	117	0	**117**
Dec-24	365	800	277	1,079	**2,522**	13	4	184	61		**263**	259	0	**259**
Jan-25	417	935	299	1,103	**2,754**	8	2	184	46		**240**	259	0	**259**
Feb-25	688	2,220	575	1,240	**4,723**	16	2	167	226		**411**	235	0	**235**
Mar-25	823	2,516	400	1,324	**5,062**	10	3	235	401		**649**	59	0	**59**
Apr-25	1,000	3,236	705	1,323	**6,264**	40	3	297	104		**444**	214	0	**214**
May-25	925	3,313	975	1,420	**6,633**	51	3	430	141		**625**	174	0	**174**
Jun-25	770	3,203	866	1,498	**6,338**	13	3	493	255		**764**	91	0	**91**
Jul-25	701	2,743	691	1,442	**5,577**	16	3	661	256		**937**	88	71	**159**
Aug-25	665	2,311	634	1,344	**4,954**	16	3	603	123		**745**	93	0	**93**
Sep-25	639	2,147	565	1,252	**4,604**	14	3	357	149		**523**	259	0	**259**
Oct-25	623	2,140	609	1,241	**4,612**	22	3	277	169		**471**	239	0	**239**
Nov-25	617	2,171	574	1,248	**4,611**	14	6	222	124		**365**	144	0	**144**
Dec-25	636	2,222	574	1,260	**4,692**	14	6	200	91		**311**	155	0	**155**
Jan-26	637	2,271	546	1,273	**4,727**	10	3	200	92		**305**	259	0	**259**
Feb-26	787	3,129	789	1,347	**6,052**	9	0	0	4		**13**	75	0	**75**
Mar-26	901	3,359	673	1,390	**6,324**	8	3	200	237		**448**	262	0	**262**
Apr-26	1,000	3,727	800	1,401	**6,929**	37	3	297	225		**562**	206	0	**206**
May-26	865	3,586	742	1,334	**6,526**	44	3	441	138		**627**	136	0	**136**
Jun-26	752	3,234	599	1,230	**5,815**	29	3	608	164		**804**	71	0	**71**
Jul-26	697	2,761	386	1,149	**4,993**	44	3	654	236		**937**	64	29	**93**
Aug-26	654	2,252	310	1,006	**4,222**	18	3	671	112		**805**	75	0	**75**
Sep-26	614	2,052	304	959	**3,929**	14	3	374	59		**451**	245	0	**245**

Table V.11.3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
(b)(2) Results														
	Storage (TAF)					**Releases (TAF)**						**Exports (TAF)**		
Date	Trinity	Shasta	Folsom	New Melones	**Total**	Goodwin	Whiskeytown	Keswick	Natoma		**Total**	Tracy	CVP wheeling	**Total**
Oct-21	1,850	2,737	400	1,007	**5,994**	7	12	373	190		**582**	270	40	**310**
Nov-21	1,837	2,658	326	1,027	**5,848**	13	12	323	149		**496**	254	40	**294**
Dec-21	1,839	2,692	350	1,065	**5,946**	13	12	300	154		**479**	185	0	**185**
Jan-22	1,836	2,751	350	1,104	**6,040**	8	12	246	123		**390**	185	0	**185**
Feb-22	1,850	3,077	575	1,212	**6,715**	22	11	222	120		**374**	236	0	**236**
Mar-22	1,890	3,407	631	1,280	**7,209**	17	12	261	247		**538**	248	0	**248**
Apr-22	1,979	3,837	741	1,250	**7,806**	60	12	327	268		**667**	45	0	**45**
May-22	1,935	4,077	975	1,415	**8,402**	92	3	492	506		**1,093**	274	0	**274**
Jun-22	1,900	3,821	975	1,694	**8,390**	13	9	647	544		**1,213**	267	0	**267**
Jul-22	1,727	3,400	949	1,636	**7,712**	18	9	769	154		**950**	187	0	**187**
Aug-22	1,666	2,887	800	1,530	**6,883**	24	3	725	225		**977**	276	0	**276**
Sep-22	1,621	2,606	634	1,419	**6,281**	14	3	479	239		**736**	263	10	**273**
Oct-22	1,598	2,622	538	1,412	**6,169**	15	12	277	184		**489**	265	20	**285**
Nov-22	1,584	2,620	447	1,432	**6,083**	17	12	268	206		**502**	252	40	**292**
Dec-22	1,586	2,681	561	1,504	**6,333**	17	12	277	305		**612**	184	0	**184**
Jan-23	1,604	2,844	553	1,570	**6,570**	17	12	246	284		**560**	0	0	**0**
Feb-23	1,619	2,925	575	1,622	**6,740**	16	11	236	144		**407**	89	0	**89**
Mar-23	1,666	3,022	575	1,655	**6,918**	19	12	235	169		**435**	161	0	**161**
Apr-23	1,781	3,266	800	1,636	**7,483**	74	12	327	199		**612**	45	0	**45**
May-23	1,663	3,031	975	1,700	**7,369**	92	12	660	262		**1,027**	153	0	**153**
Jun-23	1,491	2,763	975	1,757	**6,986**	18	9	685	157		**869**	184	0	**184**
Jul-23	1,291	2,382	950	1,695	**6,318**	16	9	745	145		**916**	68	0	**68**
Aug-23	1,200	1,900	838	1,588	**5,525**	21	9	709	192		**931**	191	0	**191**
Sep-23	1,003	1,900	661	1,487	**5,052**	15	9	349	266		**639**	253	34	**287**
Oct-23	1,000	1,855	562	1,486	**4,903**	21	9	300	194		**525**	260	40	**300**
Nov-23	981	1,811	411	1,489	**4,691**	18	9	262	202		**490**	126	33	**159**
Dec-23	965	1,786	298	1,505	**4,554**	19	9	243	167		**438**	53	0	**53**
Jan-24	951	1,802	212	1,521	**4,486**	19	9	215	133		**376**	239	0	**239**
Feb-24	1,000	1,942	203	1,534	**4,679**	18	9	201	100		**327**	54	0	**54**
Mar-24	997	1,894	202	1,534	**4,627**	8	2	289	46		**345**	2	0	**2**
Apr-24	804	1,809	238	1,474	**4,325**	31	6	458	22		**517**	77	0	**77**
May-24	564	1,635	272	1,375	**3,846**	36	6	507	22		**571**	78	0	**78**
Jun-24	491	1,252	275	1,270	**3,287**	37	6	556	34		**632**	11	0	**11**
Jul-24	384	892	254	1,221	**2,751**	40	6	584	54		**684**	14	0	**14**
Aug-24	339	550	264	1,089	**2,242**	26	6	508	23		**563**	11	0	**11**
Sep-24	272	550	223	1,062	**2,107**	14	6	272	72		**365**	170	0	**170**
Oct-24	248	550	216	1,044	**2,057**	22	6	200	47		**275**	186	0	**186**
Nov-24	315	662	260	1,057	**2,294**	12	6	193	36		**248**	125	0	**125**
Dec-24	361	751	335	1,079	**2,526**	13	6	200	31		**250**	184	0	**184**
Jan-25	413	866	295	1,103	**2,677**	8	6	200	108		**322**	184	0	**184**
Feb-25	683	2,134	575	1,240	**4,633**	16	6	180	222		**425**	217	0	**217**
Mar-25	819	2,319	400	1,324	**4,861**	10	6	342	401		**759**	170	0	**170**
Apr-25	1,000	3,031	690	1,323	**6,044**	40	6	298	119		**463**	67	0	**67**
May-25	925	3,273	932	1,420	**6,550**	51	6	264	169		**490**	69	0	**69**
Jun-25	770	3,187	849	1,498	**6,304**	13	6	467	230		**715**	56	0	**56**
Jul-25	701	2,738	728	1,442	**5,610**	16	3	649	201		**870**	53	48	**100**
Aug-25	665	2,319	702	1,344	**5,030**	16	3	591	92		**703**	61	0	**61**
Sep-25	639	2,155	632	1,252	**4,679**	14	3	357	149		**523**	253	0	**253**
Oct-25	623	2,140	613	1,241	**4,616**	22	6	274	165		**468**	238	0	**238**
Nov-25	617	2,155	553	1,248	**4,573**	14	6	239	149		**407**	172	0	**172**
Dec-25	636	2,183	490	1,260	**4,569**	14	6	222	154		**396**	80	0	**80**
Jan-26	637	2,198	416	1,273	**4,524**	10	6	231	138		**385**	184	0	**184**
Feb-26	781	2,908	552	1,347	**5,588**	9	6	194	111		**320**	234	0	**234**
Mar-26	896	3,071	535	1,390	**5,892**	8	6	231	138		**383**	245	0	**245**
Apr-26	1,000	3,431	800	1,401	**6,633**	37	6	297	87		**428**	45	0	**45**
May-26	850	3,313	727	1,334	**6,223**	44	6	430	154		**635**	46	0	**46**
Jun-26	707	3,012	643	1,233	**5,594**	26	6	585	105		**722**	5	0	**5**
Jul-26	652	2,560	511	1,156	**4,878**	40	6	631	155		**832**	4	0	**4**
Aug-26	609	2,140	429	1,012	**4,190**	19	6	579	117		**722**	3	0	**3**
Sep-26	570	1,953	407	965	**3,895**	14	6	358	74		**452**	245	0	**245**

Table V.11.4 shows the storage, release, and export changes between the WQCP study and D1485 study used to compute the WQCP cost. The D1485 study is the baseline for computing the WQCP cost.

The storage changes in CVP's Trinity, Shasta, Folsom, and New Melones Lake are shown in columns B – E; the total storage changes are shown in column F. The storage change in each month is computed by subtracting the current month's storage difference (WQCP – D1485) from the previous month's storage difference (WQCP – D1485). By sign convention, a negative value in the storage change indicates an increase in storage, and a positive value indicates a decrease (cost) in storage in the WQCP study as compared with the D1485 study. Although the storage change is computed every month, only the October through January storage change values are included in the total cost computation.

The release changes in CVP reservoirs at Goodwin Dam, Whiskeytown Lake, Keswick Rservoir, and Lake Natoma (Nimbus) are shown in columns G – J; the total release changes are shown in column L. The release change is computed by taking the difference between the WQCP and D1485 studies each month. By sign convention, a negative value indicates a decrease in release, and a positive value indicates an increase in release. Although the release change is computed every month, only the February through September values are included in the total cost computation.

The changes in CVP exports at Tracy Pumping Plant and CVP wheeling are shown in columns N and O; the total export changes are shown in column P. The export change is computed by taking the difference between the WQCP and D1485 studies each month. By sign convention, a positive value indicates a decrease (cost) in export, and a negative value indicates an increase in export.

Column Q shows the total WQCP cost which is the sum of the storage, release, and export changes. In October through January, the total cost is the sum of storage and export changes. In February through September, the total cost is the sum of release and export changes.

Column R shows the total WQCP cost with the 450 taf cap limit.

Column S shows the running (cumulative) total of the WQCP cost without the 450 taf cap. The cumulative total in September is the total CVP WQCP cost for each year without the 450 taf cap.

The running (cumulative) total of the WQCP cost with the 450 taf cap is shown in column T. The running total is computed by adding the current month's total metrics to the previous month's cumulative total cost computed from October of each year. The cumulative total in September is the total CVP WQCP cost capped at 450 taf for each year. This is the total CVP WQCP cost that is charged to the (b)(2) account.

Table V.11.4

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
													WQCP Metrics			Total Cost (TAF) Oct-Jan: storage+export Feb-Sep:Release+Export	Total cost (Taf) w/ 450 cap Oct-Jan: storage+export Feb-Sep:Release+Export	Running Total cost Oct-Jan: storage+export Feb-Sep:Release+Export	Running Total cost w/ 450 cap Oct-Jan: storage+export Feb-Sep:Release+Export
	Storage (TAF)					Releases (TAF)						Cumulative	Exports (TAF)						
Date	Trinity	Shasta	Folsom	New Melones	Total	Goodwn	Whiskeytown	Keswick	Natoma		Total	Releases	Tracy	CVP Wheeling	Total				
Oct-21	0	0	0	-3	-3	0	0	0	0		0		0	0	0	-3	-3	-3	-3
Nov-21	0	0	0	1	1	1	0	0	0		1		0	0	0	0	0	-3	-3
Dec-21	0	0	0	1	1	1	0	0	0		1		0	0	0	1	1	-2	-2
Jan-22	0	0	0	1	1	1	0	0	0		1		0	0	0	1	1	-1	-1
Feb-22	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	-1	-1
Mar-22	0	0	0	7	7	10	0	0	0		10	10	0	0	0	10	10	8	8
Apr-22	0	0	0	41	41	46	0	0	0		46	55	1	0	1	46	46	55	55
May-22	0	0	0	65	65	62	0	0	0		62	117	-55	0	-55	7	7	61	61
Jun-22	2	-2	0	9	9	0	0	0	0		0	117	-93	0	-93	-93	-93	-32	-32
Jul-22	0	0	-53	8	-44	0	0	0	-53		-53	64	8	56	65	12	12	-20	-20
Aug-22	0	0	0	8	9	0	0	0	0		0	64	0	33	33	33	33	13	13
Sep-22	0	0	81	-4	77	0	0	0	81		81	145	0	-18	-18	62	62	75	75
Oct-22	0	0	6	5	12	9	0	0	6		15		0	0	0	12	12	12	12
Nov-22	0	0	-7	5	-2	5	0	0	-7		-2		-13	0	-13	-15	-15	-3	-3
Dec-22	0	0	1	5	5	6	0	0	1		5		0	0	0	6	5	2	2
Jan-23	0	0	0	10	10	10	0	0	0		10		13	0	13	22	22	25	25
Feb-23	0	0	0	9	9	9	0	0	0		9	9	0	0	0	9	9	33	33
Mar-23	0	0	0	9	9	11	0	0	0		11	20	2	0	2	13	13	47	47
Apr-23	0	0	0	54	54	59	0	0	0		59	79	-66	0	-66	-7	-7	40	40
May-23	0	0	0	79	79	62	0	0	0		62	141	-29	0	-29	32	32	72	72
Jun-23	0	0	0	12	12	5	0	0	0		5	145	-4	0	-4	0	0	72	72
Jul-23	0	0	18	8	25	1	0	0	18		18	163	-2	-18	-20	-2	-2	70	70
Aug-23	0	0	-1	8	6	0	0	0	-1		-1	163	-55	5	-50	-51	-51	20	20
Sep-23	0	46	-16	-9	21	1	0	46	-16		31	194	-1	-30	-31	0	0	20	20
Oct-23	0	0	0	8	8	12	0	0	0		12		0	0	0	8	8	8	8
Nov-23	0	0	-19	6	-13	6	0	0	-19		-13		0	0	0	-13	-13	-5	-5
Dec-23	0	0	0	6	6	6	0	0	0		6		-4	0	-4	3	3	-2	-2
Jan-24	0	0	0	11	11	11	0	0	0		11		4	0	4	15	15	13	13
Feb-24	0	0	0	10	10	10	0	0	0		10	10	0	0	0	10	10	23	23
Mar-24	0	0	63	-2	61	0	0	0	63		63	74	101	0	101	165	165	188	188
Apr-24	0	0	-79	5	-74	11	0	0	-78		-67	7	-79	0	-79	-146	-146	41	41
May-24	0	0	0	10	10	5	0	0	0		5	12	100	0	100	105	105	147	147
Jun-24	0	0	0	51	52	0	0	0	0		0	12	-55	0	-55	-55	-55	91	91
Jul-24	0	0	0	-41	-41	0	0	0	0		0	12	1	0	1	1	1	92	92
Aug-24	0	0	0	7	7	2	0	0	0		2	13	1	0	1	2	2	94	94
Sep-24	0	0	0	-6	-5	0	0	0	0		0	13	18	0	18	18	18	112	112
Oct-24	0	0	17	12	29	15	0	0	17		32		-33	0	-33	-5	-5	-5	-5
Nov-24	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	-4	-4
Dec-24	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	-4	-4
Jan-25	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	-3	-3
Feb-25	0	0	-17	0	-17	0	0	0	-17		-17	-17	0	0	0	-17	-17	-20	-20
Mar-25	0	51	216	0	267	2	0	51	216		269	252	174	0	174	443	443	423	423
Apr-25	0	0	-121	29	-93	25	0	0	-121		-96	156	-22	0	-22	-118	-118	305	305
May-25	0	0	-95	35	-60	21	0	0	-95		-74	83	10	0	10	-64	-64	241	241
Jun-25	0	-3	-181	7	-177	0	0	-2	-181		-184	-101	88	0	88	-96	-96	146	146
Jul-25	0	-16	-190	9	-197	0	0	-15	-192		-207	-308	20	58	78	-129	-129	16	16
Aug-25	0	-3	64	8	68	-1	0	-3	61		57	-252	13	0	13	70	70	86	86
Sep-25	0	0	46	-10	36	0	0	0	45		45	-207	7	44	51	96	96	182	182
Oct-25	0	0	0	12	12	16	0	0	0		16		0	0	0	13	13	13	13
Nov-25	0	0	0	2	2	2	0	0	0		2		-63	0	-63	-62	-62	-49	-49
Dec-25	0	0	0	2	2	2	0	0	0		2		-1	0	-1	1	1	-48	-48
Jan-26	0	0	0	2	2	2	0	0	0		2		0	0	0	2	2	-46	-46
Feb-26	-6	-132	-214	1	-350	1	-3	-160	-214		-396	-396	159	0	159	-237	-237	-283	-283
Mar-26	-12	-22	145	-2	110	1	0	0	145		145	-250	0	0	0	145	145	-138	-138
Apr-26	17	-17	68	16	85	22	0	0	68		90	-160	-79	0	-79	11	11	-127	-127
May-26	-15	36	0	19	29	14	0	10	0		24	-136	16	0	16	40	40	-87	-87
Jun-26	-30	43	75	52	141	1	0	13	75		88	-47	-33	0	-33	55	55	-31	-31
Jul-26	0	13	110	-40	83	1	0	13	111		124	77	-46	9	-35	69	69	58	58
Aug-26	0	82	-177	-12	-107	-18	0	82	-177		-112	-35	-61	108	47	-65	-65	-7	-7
Sep-26	0	10	0	-12	-2	0	0	10	0		10	-26	12	0	12	21	21	14	14

Table V.11.5 shows the computations of storage, release, and export changes for computing the (b)(2) costs in the (b)(2) study as measured against the WQCP study.

The storage changes in CVP's Trinity, Shasta, Folsom, and New Melones Lake are shown in columns B – E; the total storage changes are shown in column F. The storage change in each month is computed by subtracting the current month's storage difference ((b(2) – WQCP) from the previous month's storage difference ((b)(2) – WQCP). By sign convention, a negative value in the storage change indicates an increase in storage, and a positive value indicates a decrease (cost) in storage in the (b)(2) study as compared with the WQCP study. Although the storage change is computed every month, only the October through January storage change is included in the total cost computation.

The release changes in CVP releases at Goodwin Dam, Whiskeytown Lake, Keswick Reservoir, and Lake Natoma (Nimbus) are shown in columns G – J; the total release changes are shown in column K. The release change is computed by taking the difference between the (b)(2) and WQCP studies each month. By sign convention, a negative value indicates a decrease in release, and a positive value indicates an increase in release. Although the release change is computed every month, only the February through September values are included in the total cost computation.

The changes in CVP exports at Tracy Pumping Plant and CVP wheeling are shown in columns M and N; the total export changes are shown in column O. The change in export is computed by taking the difference between the (b)(2) and WQCP studies each month. By sign convention, a positive value indicates a decrease (cost) in export, and a negative value indicates an increase in export.

Column P shows the total (b)(2) cost, without WQCP cost, and is the sum of the storage, release, and export changes between the (b)(2) and WQCP studies. In October through January, the total cost is the sum of storage and export changes. In February through September, the total cost is the sum of release and export changes.

The running (cumulative) total of the (b)(2) cost is shown in column Q. The cumulative total in September is the total end of year (b)(2) cost, without the WQCP cost, for each year.

Table V.11.5

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
											(b)(2) Metrics				Total Cost (TAF)	Running Total Cost (TAF)
	Storage (TAF)					Releases (TAF)					Cumulative	Exports (TAF)			Oct-Jan: storage+export	Oct-Jan: storage+export
Date	Trinity	Shasta	Folsom	New Melones	Total	Goodwin	Whiskeytown	Keswick	Natoma	Total	Releases	Tracy	CVP wheeling	Total	Feb-Sep:Release+Export	Feb-Sep:Release+Export
Oct-21	0	3	58	0	61	0	9	-6	58	61		0	0	0	61	61
Nov-21	0	74	40	0	114	0	6	68	40	114		-14	0	-14	100	162
Dec-21	0	106	74	0	180	0	6	100	74	180		75	0	75	255	416
Jan-22	0	55	31	0	86	0	9	46	31	86		75	0	75	161	577
Feb-22	0	50	-203	0	-153	0	8	42	-203	-153	-153	0	0	0	-153	425
Mar-22	0	70	0	0	70	0	9	61	0	71	-82	17	0	17	88	513
Apr-22	0	8	69	0	67	0	9	0	69	68	-14	176	0	176	244	757
May-22	0	-1	-59	0	-60	0	0	0	-59	-59	-73	-35	0	-35	-94	663
Jun-22	87	-89	0	0	-3	0	6	-7	0	-1	-74	5	0	5	4	667
Jul-22	61	-63	-80	-6	-88	-6	6	-7	-80	-87	-161	87	0	87	0	667
Aug-22	-31	29	71	-4	65	-4	0	0	71	66	-95	5	0	5	71	738
Sep-22	-15	14	-4	0	-5	0	0	0	-4	-4	-99	4	8	12	8	747
Oct-22	0	62	30	0	92	0	9	53	31	93		0	20	20	112	112
Nov-22	0	80	34	0	114	0	6	74	34	114		-32	0	-32	82	194
Dec-22	0	83	-64	0	19	0	6	77	-64	19		75	0	75	94	288
Jan-23	0	55	0	0	55	0	9	46	0	55		73	0	73	128	416
Feb-23	8	55	0	0	64	0	8	56	0	64	64	17	0	17	81	497
Mar-23	0	44	-15	0	29	0	9	35	-15	29	93	17	0	17	47	544
Apr-23	4	4	15	0	24	0	9	0	15	24	117	92	0	92	116	660
May-23	0	-5	0	0	-5	0	9	-13	0	-3	114	61	0	61	58	718
Jun-23	30	-42	0	0	-13	0	6	-17	0	-11	103	-1	0	-1	-12	706
Jul-23	30	-44	-26	-2	-41	-2	6	-17	-26	-39	63	15	18	32	-7	699
Aug-23	2	-13	10	-3	-5	-3	6	-16	10	-3	60	-20	16	-3	-6	693
Sep-23	157	-237	68	0	-12	0	6	-84	68	-10	50	7	-3	4	-7	686
Oct-23	0	0	46	0	46	0	6	-6	46	46		0	0	0	46	46
Nov-23	0	67	37	0	104	0	3	65	37	104		-46	0	-46	58	104
Dec-23	0	46	87	0	133	0	3	43	87	133		75	0	75	208	313
Jan-24	0	21	59	0	81	0	6	15	60	81		-29	0	-29	52	364
Feb-24	0	20	36	0	56	0	6	14	37	57	57	0	0	0	57	421
Mar-24	0	63	-64	0	-1	0	0	63	-63	0	56	1	0	1	0	421
Apr-24	99	-127	-24	0	-52	0	4	-32	-23	-51	6	9	0	9	-42	379
May-24	-31	-4	-41	0	-76	0	4	-39	-40	-74	-69	7	0	7	-67	312
Jun-24	-58	55	-57	0	-60	0	4	-7	-56	-58	-127	56	0	56	-2	310
Jul-24	-2	2	-55	0	-55	0	4	-4	-54	-54	-181	1	0	1	-53	257
Aug-24	2	-2	-39	0	-39	0	4	-4	-39	-38	-219	1	0	1	-37	220
Sep-24	19	-142	13	0	-109	0	4	-47	13	-30	-249	5	0	5	-25	195
Oct-24	0	0	-16	0	-16	0	4	15	-16	3		-3	0	-3	-19	-19
Nov-24	2	28	-11	0	19	0	2	15	-11	5		-8	0	-8	11	-8
Dec-24	3	21	-30	0	-7	0	2	15	-30	-13		75	0	75	68	60
Jan-25	0	20	62	0	81	0	4	15	61	81		75	0	75	156	217
Feb-25	0	18	-4	0	14	0	4	14	-4	14	14	17	0	17	31	248
Mar-25	0	110	0	0	110	0	3	107	0	110	124	-111	0	-111	-1	247
Apr-25	-4	8	15	0	18	0	3	1	15	19	143	147	0	147	166	413
May-25	0	-164	28	0	-136	0	3	-167	28	-135	8	105	0	105	-30	383
Jun-25	0	-24	-26	0	-49	0	3	-26	-26	-49	-41	35	0	35	-14	369
Jul-25	0	-12	-55	0	-67	0	0	-12	-55	-67	-108	35	23	58	-9	360
Aug-25	0	-12	-30	0	-42	0	0	-12	-30	-43	-151	32	0	32	-10	350
Sep-25	0	0	0	0	0	0	0	0	0	0	-151	6	0	6	6	356
Oct-25	0	0	-4	0	-4	0	3	-3	-4	-4		1	0	1	-2	-2
Nov-25	0	17	25	0	41	0	0	17	25	41		-28	0	-28	14	11
Dec-25	0	22	63	0	85	0	0	22	63	85		75	0	75	160	171
Jan-26	0	34	46	0	80	0	3	31	46	80		75	0	75	155	326
Feb-26	6	149	107	0	261	0	6	194	107	307	307	-159	0	-159	148	474
Mar-26	0	67	-99	0	-32	0	3	31	-99	-65	242	17	0	17	-48	427
Apr-26	-6	8	-138	0	-136	0	3	0	-137	-134	108	161	0	161	27	453
May-26	15	-24	15	0	7	0	3	-11	15	8	115	90	0	90	97	550
Jun-26	30	-51	-59	-3	-83	-3	3	-23	-59	-81	34	66	0	66	-15	535
Jul-26	0	-21	-81	-4	-106	-4	3	-23	-82	-105	-71	60	29	89	-16	519
Aug-26	0	-89	5	1	-83	1	3	-91	5	-83	-154	72	0	72	-11	509
Sep-26	0	-13	16	0	2	0	3	-16	15	2	-152	0	0	0	2	511

Table V.11.6 shows the total combined (b)(2) and WQCP costs.

The combined storage changes ((b)(2) + WQCP) are shown in columns B – E. The sum of the total combined storage changes for all the reservoirs are shown in column F.

The combined release changes ((b)(2) + WQCP) are shown in columns G – J. The sum of the total combined release changes for all reservoir releases are shown in column K.

Column L shows the cumulative combined (b)(2) and WQCP release changes.

Column M shows the cumulative combined (b)(2) and WQCP releases changes with offset adjustments. Column M is equal to Column L + Column O.

Column N shows the offset adjustment. The offset adjustment is the quantity of water needed to keep the change in cumulative releases from going negative in the February through September period.

The combined export changes ((b)(2) + WQCP) are shown in columns P and Q. The sum of total combined export changes are shown in column R.

Column S shows the total (b)(2) + WQCP costs and is the sum of the combined (b)(2) + WQCP storage, export, and release changes. In October through January, the total combined (b)(2) + WQCP cost is the sum of the combined (b)(2) and WQCP storage and export changes. In February through September, the total combined (b)(2) + WQCP cost is the sum of the combined (b)(2) + WQCP release and export changes and offset adjustements.

The running (cumulative) total of combined (b)(2) and WQCP cost **without** the 450 taf WQCP cost cap is shown in column T. The running total is computed as the sum of the previous month's running total from October and the current month's total combined costs. The running total at the end of September of each year is the total (b)(2) cost without the 450 taf WQCP cap.

The running (cumulative) total of combined (b)(2) and WQCP costs **with** the 450 taf WQCP cap is shown in column U. The running total is computed as the sum of the current month's total combined b(2) + WQCP cost and the running total of the WQCP cost with 450 taf cap. The running total at the end of September of each year is the total (b)(2) cost with WQCP cost capped at 450 taf.

Table V.11.6

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
											(b)(2) + WQCP Metrics							Total Cost (TAF)	Running Total Cost w/o 450 cap (TAF)	Running Total Cost w/ 450 cap (TAF)
	Storage (TAF)					Releases (TAF)					Cumulative (b)(2) and WQCP	Cumulative Release	Offset	Cumulative	Exports (TAF)			Oct-Jan: storage+export	Oct-Jan: storage+export	Oct-Jan: storage+export
Date	Trinity	Shasta	Folsom	New Melones	Total	Goodwin	Whiskeytown	Keswick	Natoma	Total	Releases	w/ Offset adjustment	adjustment	Offset	Tracy	CVP Wheeling	Total	Feb-Sep: Release+Export+Offset	Feb-Sep: Release+Export+Offset	Feb-Sep: Release+Export+Offset
Oct-21	0	3	58	-3	58	0	9	-6	58	62	0	0	0		0	0	0	58	58	58
Nov-21	0	74	40	1	115	1	6	68	40	115	0	0	0		-14	0	-14	101	159	159
Dec-21	0	106	74	1	181	1	6	100	74	181	0	0	0		75	0	75	256	414	414
Jan-22	0	55	31	1	87	1	9	46	31	87	0	0	0		75	0	75	162	576	576
Feb-22	0	50	-203	0	-153	0	8	42	-203	-153	-153	0	153	153	0	0	0	0	576	576
Mar-22	0	70	0	7	78	10	9	61	0	80	-72	0	-80	72	18	0	18	18	594	594
Apr-22	0	8	59	41	109	46	9	0	59	114	41	41	-72	0	176	0	176	218	811	811
May-22	0	-1	-69	65	5	62	0	0	-69	3	44	44	0	0	-90	0	-90	-87	724	724
Jun-22	89	-92	0	9	6	0	6	-7	0	-1	43	43	0	0	-89	0	-89	-90	634	634
Jul-22	61	-63	-133	3	-133	-6	6	-7	-133	-140	-97	0	97	97	95	56	152	109	743	743
Aug-22	-31	29	72	4	73	-4	0	0	71	66	-31	0	-66	31	5	33	38	38	781	781
Sep-22	-15	14	77	-4	72	0	0	0	77	77	46	46	-31	0	4	-10	-6	40	821	821
Oct-22	0	62	37	-5	104	9	9	53	37	108	0	0	0		0	20	20	124	124	124
Nov-22	0	80	27	5	112	5	6	74	27	112	0	0	0		-45	0	-45	67	191	191
Dec-22	0	83	-64	5	24	6	6	77	-64	24	0	0	0		75	0	75	99	290	290
Jan-23	0	55	0	10	65	10	9	46	0	65	0	0	0		85	0	85	150	441	441
Feb-23	8	55	0	9	72	9	8	56	0	73	73	73	0	0	17	0	17	90	531	531
Mar-23	0	44	-15	9	37	11	9	35	-15	40	113	113	0	0	20	0	20	60	591	591
Apr-23	4	4	16	54	78	59	9	0	15	83	196	196	0	0	26	0	26	110	700	700
May-23	0	-6	0	79	75	62	9	-13	0	58	255	255	0	0	32	0	32	90	790	790
Jun-23	30	-42	0	12	-1	-5	6	-17	0	-7	248	248	0	0	-5	0	-5	-12	778	778
Jul-23	30	-44	-8	6	-16	-1	6	-17	-8	-21	227	227	0	0	12	0	12	-9	770	770
Aug-23	2	-13	8	5	2	-2	6	-16	8	-4	223	223	0	0	-74	21	-53	-57	713	713
Sep-23	157	-190	52	-9	9	1	6	-38	52	21	244	244	0	0	6	-34	-28	-7	706	706
Oct-23	0	0	46	8	54	12	6	-6	46	58	0	0	0		0	0	0	-54	-54	54
Nov-23	0	67	18	6	91	6	3	65	18	91	0	0	0		-46	0	-46	45	100	100
Dec-23	0	46	87	6	140	6	3	43	87	140	0	0	0		71	0	71	211	311	311
Jan-24	0	21	59	11	92	11	6	15	60	92	0	0	0		-25	0	-25	66	377	377
Feb-24	0	20	36	10	66	10	6	14	37	67	67	67	0	0	0	0	0	67	444	444
Mar-24	0	63	-1	-2	60	0	0	63	0	63	130	130	0	0	102	0	102	165	609	609
Apr-24	99	-127	-103	5	-126	11	4	-32	-102	-118	12	12	0	0	-70	0	-70	-188	421	421
May-24	-31	-4	-41	10	-66	5	4	-39	-40	-69	-56	0	56	56	107	0	107	94	515	515
Jun-24	-58	55	-56	61	8	0	4	-7	-56	-58	-115	0	58	115	1	0	1	1	516	516
Jul-24	-2	2	-54	-42	-96	0	4	-4	-54	-54	-169	0	54	169	2	0	2	2	518	518
Aug-24	2	-2	-38	7	-32	2	4	-4	-39	-37	-205	0	37	205	2	0	2	2	520	520
Sep-24	19	-142	13	-6	-115	0	4	-47	13	-30	-235	0	30	235	23	0	23	23	543	543
Oct-24	0	8	1	12	13	15	4	15	1	36	0	0	0		-36	0	-36	-24	-24	-24
Nov-24	2	28	-11	0	19	0	2	15	-11	6	0	0	0		-8	0	-8	11	-12	-12
Dec-24	3	21	-30	0	-6	0	2	15	-30	-12	0	0	0		75	0	75	69	57	57
Jan-25	0	20	61	0	82	0	4	15	61	82	0	0	0		75	0	75	157	213	213
Feb-25	0	18	-21	0	-3	0	4	14	-21	-3	-3	0	3	3	17	0	17	17	231	231
Mar-25	0	161	216	0	377	2	3	158	216	380	376	376	-3	0	63	0	63	439	670	670
Apr-25	-4	8	-107	29	-74	25	3	1	-106	-77	299	299	0	0	125	0	125	48	718	718
May-25	0	-164	-66	35	-195	21	3	-167	-66	-209	90	90	0	0	115	0	115	-94	624	624
Jun-25	0	-26	-206	7	-226	0	3	-29	-207	-233	-142	0	142	142	123	0	123	32	657	657
Jul-25	0	-28	-245	9	-264	0	0	-28	-247	-274	-417	0	274	417	55	81	136	136	793	793
Aug-25	0	-15	34	8	26	-1	0	-15	31	14	-403	0	-14	403	45	0	45	45	838	838
Sep-25	0	0	47	-10	37	0	0	0	45	45	-358	0	-45	358	13	44	57	57	895	895
Oct-25	0	0	-4	12	9	16	3	-3	-4	12	0	0	0		2	0	2	10	10	10
Nov-25	0	17	25	2	43	2	0	17	25	43	0	0	0		-91	0	-91	-48	-38	-38
Dec-25	0	22	63	2	87	2	0	22	63	87	0	0	0		74	0	74	161	123	123
Jan-26	0	34	46	2	82	2	3	31	46	82	0	0	0		75	0	75	157	280	280
Feb-26	0	17	-107	1	-89	1	3	14	-107	-89	-89	0	89	89	0	0	0	0	280	280
Mar-26	-12	45	46	-2	78	1	3	31	46	80	-8	0	-80	8	17	0	17	17	297	297
Apr-26	12	-9	-69	16	-51	22	3	0	-69	-44	-52	0	44	52	82	0	82	82	379	379
May-26	0	2	15	19	36	14	3	0	15	32	-20	0	-32	20	105	0	105	105	484	484
Jun-26	0	-7	16	49	58	-2	3	-10	16	7	-13	0	-7	13	33	0	33	33	517	517
Jul-26	0	-8	29	-44	-23	-3	3	-10	29	19	6	6	-13	0	16	38	54	60	577	577
Aug-26	0	-6	-172	-11	-189	-17	3	-9	-172	-195	-189	0	189	189	12	108	120	114	691	691
Sep-26	0	-4	15	-12	0	0	3	-6	15	12	-178	0	-12	178	12	0	12	12	702	702

VI Appendix A: Comparison of Regulatory Standards, Actions and Operational Constraints

	D1485	WQCP	WQCP + B2	WQCP + B2+ EWA
	Trinity River			
Minimum req't instream flow	369-815 taf/year, depending on Trinity River Index	same	same	same
	Clear Creek			
Minimum req't instream flow	1963 USBR proposal to FWS: 50-100 cfs	same as D1485 plus	same as D1485 plus CVPIA (b2) AFRP Upstream Action #1 (Nov. 20, 1997): Oct – Sep With stability criteria	same as D1485 plus CVPIA (b2) AFRP Upstream Action #1 (Nov. 20, 1997): Oct – Sep With stability criteria
	Sacramento River			
Minimum req't instream flow below Keswick **<u>Shasta Storage</u>: End-of-Sep. minimum storage**	1993 Winter-run Biological Opinion with estimated temperature control flows in Apr – Sep. These flows are a proxy for temp. control and do not guarantee meeting the temp. objectives 1900 taf, 1993 Winter-run Biological Opinion	same same	Same as D1485 plus CVPIA (b2) AFRP Upstream Action #2 (Nov. 20, 1997): Oct – Sep With stability criteria same	same as D1485 plus CVPIA (b2) AFRP Upstream Action #2 (Nov. 20, 1997): Oct – Sep With stability criteria same
Navigation Control Point (NCP)	Flow objective:3500-5000 cfs	same	same	same
	American River			
Minimum req't instream flow at Nimbus	500-2750 cfs (Oct) 500-2500 cfs (Nov) 500-3000 cfs (Dec-Feb) 250-3000 cfs (Mar) 250-3000 cfs (Apr) 500-3000 cfs (May) 1000-3000 cfs (Jun) 750-3000 cfs (Jul) 750-2500 cfs (Aug) 500-2500 cfs (Sep) Flows are dependent on storage and/or and storage + inflow	same	Same as D1485 plus CVPIA (b2) AFRP Upstream Action #3 (Nov. 20, 1997): Oct – Sep With stability criteria	same as D1485 plus CVPIA (b2) AFRP Upstream Action #3 (Nov. 20, 1997): Oct – Sep With stability criteria
Minimum req't instream flow at H Street	SWRCB D893 250-500 cfs, with 25% relaxation in crit.years.	same	same	same

	D1485	WQCP	WQCP + B2	WQCP + B2+ EWA
	Feather River			
Minimum req't instream flow below Thermalito Diversion Dam	600 cfs	same	same	same
Minimum req't instream flow below Thermalito Afterbay	900 – 1700 cfs (Oct. – Feb.) 760 – 1700 cfs (Mar.) 760 – 1000 cfs (Apr. – Sep.), depending on April – July unimpaired runoff in the Feather R. near Oroville	same	same	same
	Lower Sacramento River			
Freeport	None	None	None	None
Minimum req't instream flow at Rio Vista	2500 cfs (Jan - W, AN, BN yrs) 1500 cfs (Jan - D & C yrs) 3000 cfs (Feb1- Mar15, W Yrs) 2000 cfs (Feb1-Mar15, AN & BN yrs) 1000 cfs (Feb1- Mar15, D &C Yrs) 5000 cfs (Mar16-Jun30, W Yrs) 3000 cfs (Mar16-Jun30AN & BN Yrs) 2000 cfs (Mar16-Jun30, D & C Yrs) 3000 cfs (Jul, W Yrs) 2000 cfs (Jul, AN & BN Yrs) 1000 cfs (Jul, D &C Yrs) 1000 cfs (Aug, W, AN, BN, D, C Yrs) 5000 cfs (Sep-Dec, W Yrs) 2500 cfs (Sep-Dec, AN, BN Yrs) 1500 cfs (Sep-Dec, D &C Yrs)	3000 cfs (Sep - all year types) 4000 cfs (Oct-W, AN, BN, D yrs) 3000 cfs (Oct-C Yrs) 4500 cfs (Nov - Dec:W,AN,BN,D yrs) 3500 cfs (Nov -Dec: C Yrs)	Same as WQCP	same as WQCP
	San Joaquin River			
Minimum req't instream flow at Vernalis	None	Vernalis Adaptive Management Plan (VAMP) Target flows: 2000, 3200, 4450, 5700, 7000 cfs (Apr15-May15) Oct. min. flow of 1000 cfs and pulse flow of 28 taf	Same as WQCP	same as WQCP
Salinity standards at Vernalis	700 EC (Apr – Aug) 1000 EC (Sep – Mar) New Melones makes release for salinity. The release cap is 70-225 taf/year based on New Melones forecast inflow	700 EC (Apr – Aug) 1000 EC (Sep – Mar) New Melones makes release for salinity. The release cap is 70-250 taf/year based on New Melones forecast inflow	Same as WQCP	same as WQCP

	D1485	WQCP	WQCP + B2	WQCP + B2+ EWA
	Tuolumne River			
Minimum req't instream flow	FERC 2299-024 1995 90-300 taf/year	same	same	same
	Stanislaus River			
Minimum req't instream flow	98 – 302 taf/year based on New Melones forecast inflow	New Melones Interim Op. Plan 98 – 472 taf/year based on New Melones forecast inflow	Same as WQCP	same as WQCP
CSJWCD Delivery	0-80 taf/year based on New Melones forecast inflow	same	same	same
SEWD Delivery	0-10 taf/year based on New Melones forecast inflow	same	same	same
OID/SSJID Delivery	Qin>600 taf: 600 taf/year Qin<600 taf: Qin + 1/3(600-Qin) Where Qin is the New Melones forecast inflow	200-600 taf/year based on New Melones forecast inflow	Same as WQCP	same as WQCP
Dissolved Oxygen	Jun: 13.2 taf, Jul:16.2 taf, Aug:16.4 taf, Sep:14.3 taf	same	Same	same
	Merced River			
Minimum req't instream flow	35-47 taf/year based on 60-20-20 index	same	Same	same
	Delta			
Delta outflow & salinity	D1485 water quality standards (Artificial Neural Network implementation)	WQCP water quality standards (Artificial Neural Network implementation)	same as WQCP	same as WQCP
Delta Cross Channel Gates	Closed Jan-May when Delta outflow is greater than 12000 cfs Closed when Freeport flow is greater than 25000 cfs. Closed Feb – Apr (1993 Winter-run Biological Opinion)	Closed: 10 days in Nov 15 days in Dec 20 days in Jan Feb. 1 – Jun 4 Closed when Freeport flow is greater than 25,000 cfs.	same as WQCP	same as WQCP

	D1485	WQCP	WQCP + B2	WQCP + B2+ EWA
Delta Export Restrictions	May & Jun: 3000 cfs at Tracy and Banks July: 4600 cfs at Tracy and Banks	Export/Inflow Ratio: 65%: Oct – Jan 35-45%: Feb 35%: Mar – Jun 65%: Jul – Sep When EI controls, allowable pumping is split 50/50 between CVP&SWP 1:1 export criteria - Apr15-May15	same as WQCP plus **B(2) Actions (See Matrix of Potential CVPIA (b)(2) Actions table) only for CVP export.** VAMP Vernalis Flow, cfs / Exports, cfs 2000 1500 3200 1500 4450 1500 5700 2250 7000 1500 or 3000	same as WQCP + B2 plus **EWA Actions (See Matrix of Potential EWA Actions table) for SWP and CVP export.** VAMP Vernalis Flow, cfs / Exports, cfs 2000 1500 3200 1500 4450 1500 5700 2250 7000 1500 or 3000
Tracy Pumping	Tracy capacity is assumed at 4600 cfs. How ever, in some months, it is limited to 4200 cfs by the capacity in the upper DMC.	same	Same	same
	Operations Criteria in Delta			
COA	1986 Agreement between DWR and USBR Storage withdrawals for in-basin use are shared 75% CVP and 25% SWP Unstored flows for storage and export are shared 55% CVP and 45% SWP	same	Same	Same
CVP Wheeling	CVP payback wheeling (196 taf) in Jul and Aug Banks can wheel up to 128 taf/year for Cross Valley Canal Cross Valley Canal delivery is wheeled directly from Banks P.P. from July through December up to CVC's allocation	Banks can wheel up to 128 taf/year for Cross Valley Canal Cross Valley Canal delivery is wheeled directly from Banks P.P. from July through December up to CVC's allocation	Banks can wheel up to 128 taf/year for Cross Valley Canal CVC wheeling is modeled the same as WQCP	Full and unlimited joint point of diversion for CVP and EWA. Note: ESA "take limits", power costs, and other fishery concerns that may inhibit the wheeling of water through the Delta were not modeled. Banks can wheel up to 128 taf/year for Cross Valley Canal CVC wheeling is modeled the same as WQCP